

MEMORANDUM
RM-5201-ARPA
MARCH 1967

AD 650470

BASIC ENERGY-LEVEL
AND EQUILIBRIUM DATA FOR
ATMOSPHERIC ATOMS AND MOLECULES

Forrest R. Gilmore

PREPARED FOR:
ADVANCED RESEARCH PROJECTS AGENCY

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This research is supported by the Advanced Research Projects Agency under Contract No. SD-79. Any views or conclusions contained in this Memorandum should not be interpreted as representing the official opinion or policy of ARPA.

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SUMMARY

This memorandum presents tables of the formation energies, dissociation energies, ionization energies, electronic energy levels, and vibrational level spacings for most atomic, diatomic, and triatomic molecules involving hydrogen, carbon, nitrogen, oxygen, and argon. Many positively and negatively charged ions are included. Tables of equilibrium fractional electronic-state populations, and graphs of the equilibrium constants for dissociation, ionization, and detachment for most of the atomic and diatomic species are appended. A brief discussion of the significance of such data precedes the tables and graphs.

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I. INTRODUCTION

An important property of any reaction is its reaction energy, i.e., the amount of energy taken up or given off when unit amounts of the reactants are converted to the products. Heats of formation, dissociation energies, ionization energies, etc., represent specific types of reaction energies. When a reaction is exothermic, the reaction energy represents the energy available for excitation or heating of the products of the reaction. When a reaction is endothermic, the reaction energy must be supplied by the thermal or excitational energy of the reactants. Consequently, endothermic reactions will be very slow when the mean thermal energy is much less than the reaction energy, unless the reactants have above-thermal excitational energy. (The converse, however, is not true; reactions are not necessarily fast just because sufficient energy is available.)

An understanding of reactions involving excited states also requires a knowledge of the excited energy levels of the reacting or product species. Moreover, for the case of thermal equilibrium (i.e., for a Boltzmann distribution of excited-state populations), such energy levels can be used to calculate "equilibrium constants" which relate the forward to the backward rates of reactions (see Section 4). Finally, since most reaction energies and energy levels can be determined (by spectroscopic, calorimetric, or other measurements) with an accuracy far surpassing that attainable in reaction-rate measurements, such data form a firm foundation on which to build the often crude and speculative edifices of reaction mechanisms and rates. The present memorandum presents such data for atoms and simple molecules involving hydrogen, carbon, nitrogen, oxygen, and argon. These data have been obtained by a critical study of the recent literature, combined with new thermodynamic calculations for some of the species.

II. REACTION ENERGIES

The energy of a reaction may be defined as the amount of energy taken up when one molecule or one mole of reactants reacts to form products. Unless otherwise stated, all reactants and products are assumed to be in their ground rotational, vibrational, and electronic levels (i.e., no excitation). Such a reaction energy is equivalent to what chemists call "the heat of reaction at 0°K ", since at absolute zero (in thermal equilibrium) all particles are in their lowest levels. Moreover, for gases at absolute zero no distinction needs to be made between the reaction enthalpy (or heat) and the reaction energy, since $\Delta H_0^\circ - \Delta E_0^\circ = \Delta(pV)_{T=0} = 0$, where by international convention the subscript "0" designates 0°K and the superscript "o" the ideal gas state. (A similar relation holds for the free energy: $\Delta F_0^\circ = \Delta A_0^\circ = \Delta E_0^\circ$.)

Chemists usually consider the reaction energy to vary with temperature, because of the varying thermal energy of the reactants and products. However, only the zero-temperature reaction energy will be tabulated here, for two reasons. In the first place, the variation with temperature is usually relatively small except at high temperatures, and can be readily estimated if necessary. Secondly, and more important in the present context, it is highly unlikely that the reaction products will be formed with an initial energy distribution corresponding to the ambient gas temperature. Hence, the temperature-dependent reaction energy is not really pertinent to the reaction-rate problem, but only to the question of the net heating after the products are thermalized by subsequent collisions.

The sign of the reaction energy depends upon whether it is defined as the energy absorbed or the energy released on reaction. For the cases considered here it is conventional to define it as the energy absorbed during formation, dissociation, or ionization, or equivalently the excess of the internal energy of the products over that of the reactants.

Before standard heats of formation can be determined, it is also necessary to establish "reference states" which are the standard substances from which all the other species are formed. For the species of present interest the conventional reference states are H_2 , N_2 , O_2 , and Ar in the ideal-gas (or isolated-molecule) state, and C in the form of graphite.

Table 1 gives the molecular weight, energy of formation, dissociation energy, and ionization energy for the (gaseous) atoms and small molecules of present interest, together with the relevant references. All energies are given in three different units: physical (electron volts per particle), spectroscopic (reciprocal of the wavelength of photons with that energy, in 10^3 cm^{-1} , also known as kilokaysers), and thermochemical (kilocalories per mole). Conversion factors are taken from the recent NAS-NRC list.⁽¹⁾ The accuracy of each value is indicated roughly by the number of decimal places shown. The energy of any other reaction involving these species may be readily calculated by adding the formation energies of the products and subtracting those of the reactants.

III. ENERGY LEVELS

The energy levels of atoms and atomic ions depend upon the arrangement of their orbital electrons. The lower energy levels of the atoms and ions of present interest are listed in Tables 2 to 11, together with their electronic state designation and statistical weight. (For an explanation of the latter terms see Herzberg⁽²⁾ or Moore⁽³⁾.) The ions H^- , H^+ , and C^- have only one bound state, so they are not tabulated. All of the listed species except O^- actually have an infinite number of highly-excited states. The present tables, however, list only those states where all the bound electrons have principal quantum numbers less than 4. In most physical situations higher states will not play an important role, but if needed they can be obtained from the more extensive tabulations of Moore,⁽³⁾ or they may be calculated from the Rydberg formula.⁽²⁾

Also included in Tables 2 to 11 are the equilibrium fractional populations of the different electronic states, for various temperatures up to $10,000^\circ K$. These results are often useful in problems concerning equilibrium gases. The reader is cautioned, however, that in many situations involving low-density gases, or transient processes even at high densities, equilibrium will not obtain and these tabulated populations will not be applicable.

Molecules, because of their additional rotational and vibrational degrees of freedom, have so many individual energy levels that it is rather impractical to tabulate them. Fortunately, however, for each degree of electronic excitation the rotational and vibrational levels are usually quite regular and can be represented by simple formulas, only the coefficients of which need to be tabulated (see Herzberg⁽⁴⁾). For present purposes it is probably sufficient to note that the vibrational levels of each electronic state are fairly evenly spaced, only slowly converging near the dissociation limit. The rotational levels are not evenly spaced, but vary approximately quadratically with the rotational quantum number; however, the spacing is generally so close (10^{-3} to 10^{-2} eV) that for most reaction-rate purposes the rotational energy levels can be treated as if they formed a continuum.

Tables 12 to 18 present the electronic energy, lowest vibrational interval, and fractional population for the lower electronic states of several diatomic molecules of present interest. Similar values for other diatomic molecules, but without the fractional population numbers, are given in Table 19. (Again, the reader is cautioned against use of the equilibrium population values in nonequilibrium situations.)

For triatomic molecules, existing knowledge of the lower excited electronic states is quite incomplete. Consequently, only the ground state and its lowest vibrational intervals, for the three normal vibrational modes, are listed in Table 20.

IV. EQUILIBRIUM CONSTANTS

In any ideal-gas mixture in complete thermal and chemical equilibrium that contains three or more species which can be related by a possible reaction, such as $XY \rightleftharpoons X + Y$ or $W + X \rightleftharpoons Y + Z$, the concentration ratios $(X)(Y)/(XY)$, $(Y)(Z)/(W)(X)$, etc., can be shown to depend only on the temperature.⁽⁵⁾ Since these ratios are independent of the individual species concentrations, they are called equilibrium constants.

A reacting gas mixture that is initially out of chemical equilibrium will tend to approach equilibrium, and the ratios defined above will tend to approach their equilibrium values. As equilibrium is approached the various reaction rates do not actually become small, but instead each reaction becomes balanced by its reverse reaction. Consequently, it can be shown that in equilibrium the ratio of the forward to backward rate coefficients for each reaction is equal to its equilibrium constant. Unfortunately, a rate coefficient is measureable and has practical significance only in nonequilibrium situations. Among each reactant species there will always be particles with a range of velocities, and usually with a range of rotational, vibrational, or electronic levels. Generally some of these levels or velocities will be more reactive than others. In nonequilibrium situations the more reactive ones will be removed (by reaction) more rapidly than the others, resulting in an internal distribution of levels or velocities in each reacting species which makes it less reactive than if it had an equilibrium distribution.⁽⁶⁾

Molecular dissociation calculations based on a simple model show that when the mean thermal energy is much less than the dissociation energy the dissociation and association coefficients are only slightly smaller than their equilibrium values. Moreover, both coefficients are decreased by the same fraction, so that their ratio still equals the equilibrium constant.⁽⁷⁾ However, other types of reactions may not have such a convenient behavior.

In the present work, equilibrium constants have been calculated for several pertinent dissociation and ionization reactions. Results up to $10,000^{\circ}\text{K}$ are presented graphically in Figs. 1 to 4.

Table 1. MOLECULAR WEIGHTS AND ENERGIES OF FORMATION, DISSOCIATION, AND IONIZATION FOR SELECTED ATOMS AND MOLECULES

Species	Molec. Weight*	Energy (or Heat) of Formation**	Dissociation Energy**	Ionization Energy**	Reference ***
H ⁻	1.00852	1.485 eV 11.974 × 10 ³ cm ⁻¹ 34.235 kcal/mole	-	0.754 6.083 17.392	8
H	1.00797	2.239 18.057 51.627	-	13.598 109.679 313.585	3
H ⁺	1.00742	15.837 127.736 365.213	-	-	-
C ⁻	12.01170	6.24 50.4 144.0	-	1.13 9.1 26.0	9,10
C	12.01115	7.371 59.452 169.979	-	11.259 90.814 259.648	3
C ⁺	12.01060	18.630 150.265 429.627	-	24.382 196.659 562.272	3
N	14.0067	4.880 39.359 112.532	-	14.532 117.214 335.129	3
N ⁺	14.0062	19.412 156.573 447.661	-	29.601 238.751 682.618	3
O ⁻	15.9999	1.079 8.705 24.89	-	1.478 11.925 34.10	11
O	15.9994	2.558 20.630 58.984	-	13.118 109.837 314.037	3

Table 1 (Cont.)

Species	Molec. Weight*	Energy (or Heat) of Formation**	Dissociation Energy**	Ionization Energy**	References ***
O ⁺	15.9989	16.175 ev 130.467 x10 ³ cm ⁻¹ 373.021 kcal/mole	-	35.117 283.244 809.829	3
Ar	39.948	0 0 0	-	15.759 127.110 363.423	3
Ar ⁺	39.947	15.759 127.110 363.423	-	27.629 222.848 637.149	3
H ₂	2.01594	0 0 0	4.477 36.114 103.254	15.425 124.414 355.715	13, 14
H ₂ ⁺	2.01539	15.425 124.414 355.715	2.651 21.379 61.125	-	14
CO	28.0106	-1.179 -9.513 -27.200	11.108 89.595 256.163	14.013 113.029 323.163	15 to 18
CO ⁺	28.0100	12.834 103.516 295.963	8.354 67.380 192.648	27.8 224 640	19
N ₂	28.0134	0 0 0	9.759 78.717 225.061	15.580 125.667 359.297	17, 20, 21
N ₂ ⁺	28.0129	15.580 125.667 359.297	8.711 70.264 200.893	27.1 219 626	22
NO ⁻	30.0066	0.6 5 14	5.3 43 123	0.3 2 7	†

Table 1 (Cont.)

Species	Molec. Weight*	Energy (or Heat) of Formation**	Dissociation Energy**	Ionization Energy**	References***
NO	30.0061	0.931 ev 7.506 · 10 ³ cm ⁻¹ 21.46 kcal/mole	6.507 52.483 150.055	9.267 74.747 213.711	15 23, 24
NO ⁺	30.0056	10.198 82.253 235.17	10.857 (N - O ⁺) 87.573 250.382	30.5 246 703	19
O ₂ ⁻	31.9993	-0.43 -3.5 -10.0	4.08 32.9 94.0	0.43 3.5 10.0	25
O ₂	31.9988	0 0 0	5.115 41.260 117.967	12.063 97.295 278.178	26, 27
O ₂ ⁺	31.9983	12.063 97.295 278.178	6.670 53.802 153.826	24.2 195 558	22
OH ⁻	17.0079	-1.43 -11.51 -32.9	4.75 (O ⁻ - H) 38.27 109.4	1.83 14.75 42.2	28
OH	17.0074	0.401 3.24 9.26	4.395 35.45 101.33	13.34 107.6 307.6	29 through 31
OH ⁺	17.0068	13.74 110.8 316.8	4.65 (O - H ⁺) 37.5 107.2	- - -	-
H ₂ O	18.0153	-2.476 -19.972 -57.103	5.116 (H - OH) 41.27 117.98	12.619 101.78 291.0	15, 32
H ₂ O ⁺	18.0148	10.143 81.81 233.9	5.84 (H - OH ⁺) 47.1 134.7	- - -	-
CO ₂	44.0100	-4.075 -32.865 -93.965	5.453 (CO - O) 43.982 125.750	13.769 111.06 317.5	15, 32

Table 1 (Cont.)

Species	Molec. Weight*	Energy (or Heat) of Formation**	Dissociation Energy**	Ionization Energy**	References***
CO_2^+	44.0094	9.694 eV 78.19 $\times 10^3 \text{ cm}^{-1}$ 223.5 kcal/mole	5.179 (CO - O^+) 41.77 119.4	22.6 182 521	19
NO_2^-	46.0060	-3.6 -29 -83	5.6 (NO - O^-) 45 128	4.0 32 92	33
NO_2	46.0055	0.372 3.00 8.59	3.116 (NO - O) 25.13 71.86	9.78 78.9 225.6	15, 34
NO_2^+	46.0050	10.15 81.9 234.2	2.60 (NO^+ - O) 21.0 60.0	- - -	-
N_2O	44.0128	0.881 7.107 20.32	1.677 (N_2 - O) 13.523 38.66	12.894 104.00 297.35	15, 32
N_2O^+	44.0123	13.775 111.11 317.67	1.302 (N - NO^+) 10.50 30.02	- - -	-
O_3^-	47.9987	-0.4 -3 -9	1.5 (O_2 - O^-) 12 34	1.9 15 44	35
O_3	47.9982	1.506 12.15 34.74	1.051 (O_2 - O) 8.48 24.25	12.80 103.2 295.2	15, 36
O_3^+	47.9977	14.31 115.4 329.9	0.32 (O_2^+ - O) 2.5 7.3	- - -	-

* Molecular weights are for the normal isotopic mixture, based on $\text{C}^{12} = 12.00000$.

** All reaction energies are for isolated particles in their lowest rotational, vibrational, and electronic state (microscopic description), or for ideal gases at 0°K (equivalent macroscopic description). All energies are given in three units: physical (electron volts), spectroscopic (10^3 cm^{-1} or kilokaysers), and thermochemical (kilocalories per mole).

*** To avoid unnecessary duplication, references are indicated only where they give directly a formation, dissociation, or ionization energy. Where a dissociation energy is calculated from the formation energies of the molecule and its dissociation products, references to the latter are given only opposite the products. Similarly, no direct references are given for formation energies calculated from measured dissociation or ionization energies.

† Electron affinity estimated, since observation of negative charge transfer(37) to O_2 shows that the magnetron measurement (33) is inaccurate.

Table 2. ENERGY LEVELS AND EQUILIBRIUM FRACTIONAL ELECTRONIC POPULATIONS OF H

STATE	LEVEL (CM-1)	LEVEL (EV)	STAT. WT.	TEMPERATURE (DEG K)									
				200	250	300	400	500	600	800	1000	1500	
1s	C	C.CCCC	2	1.00E 00	1.00E 00	1.00E 00	1.00E 00	1.00E 00	1.00E 00	1.00E 00	1.00E 00	1.00E 00	
2s	82259	10.1986	2	C.	C.	0.	0.	C.	C.	0.	0.	5.41E-35	
2p	82259	10.1986	6	0.	0.	0.	0.	0.	0.	0.	0.	1.62E-34	
3s	97492	12.0872	2	0.	0.	0.	C.	0.	C.	C.	C.	0.	
3p	97492	12.0872	6	0.	0.	0.	0.	0.	C.	0.	0.	0.	
3d	97492	12.0872	10	0.	C.	0.	0.	0.	C.	0.	0.	0.	
4s	102824	12.7482	2	0.	0.	0.	0.	C.	C.	C.	0.	0.	
4p	102824	12.7482	6	C.	0.	0.	0.	0.	C.	0.	0.	0.	
4d	102824	12.7482	10	0.	0.	C.	0.	0.	0.	0.	0.	0.	
4f	102824	12.7482	14	0.	0.	0.	0.	0.	0.	0.	0.	0.	

ENERGY LEVELS FROM MOORE (3).

NOTE: STATES INVOLVING ELECTRONS WITH PRINCIPAL QUANTUM NUMBERS ABOVE N = 4 ARE NOT INCLUDED.

LEVEL (CM-1)	TEMPERATURE (DEG K)											
	2000	2500	3000	3500	4000	4500	5000	6000	7000	8000	9000	10000
C	1.00E 00	1.00E 00	1.00E 00	1.00E 00	1.00E 00	1.00E 00	1.00E 00	1.00E 00	1.00E 00	1.00E 00	1.00E 00	1.00E 00
82259	1.99E-26	2.75E-21	7.36E-18	2.06E-15	1.41E-13	3.78E-12	5.25E-11	2.71E-09	4.54E-08	3.76E-07	1.94E-06	7.24E-06
82259	5.98E-26	8.26E-21	2.21E-17	4.18E-15	4.24E-13	1.13E-11	1.57E-10	8.14E-09	1.36E-07	1.13E-06	5.83E-06	2.17E-05
97492	3.47E-31	4.29E-25	4.94E-21	3.93E-18	5.89E-16	2.90E-14	6.55E-13	7.03E-11	1.98E-09	2.43E-08	1.70E-07	8.09E-07
97492	1.04E-30	1.29E-24	1.48E-20	1.18E-17	1.77E-15	8.70E-14	1.97E-12	2.11E-10	5.95E-09	7.28E-08	5.11E-07	2.43E-06
97492	1.74E-30	2.15E-24	2.47E-20	1.97E-17	2.95E-15	1.45E-13	3.28E-12	3.51E-10	9.92E-09	1.21E-07	8.52E-07	4.05E-06
102824	7.50E-33	1.99E-26	3.83E-22	4.39E-19	8.66E-17	5.27E-15	1.41E-13	1.96E-11	6.63E-10	9.30E-09	7.26E-08	3.76E-07
102824	2.75E-32	5.98E-26	1.15E-21	1.32E-18	2.60E-16	1.58E-14	4.24E-13	5.87E-11	1.59E-09	2.79E-08	2.18E-07	1.13E-06
102824	3.75E-32	9.97E-26	1.91E-21	2.20E-18	4.33E-16	2.64E-14	7.06E-13	9.78E-11	3.31E-09	4.65E-08	3.63E-07	1.88E-06
102824	5.25E-32	1.40E-25	2.68E-21	3.07E-18	6.06E-16	3.69E-14	9.89E-13	1.37E-10	4.64E-09	6.51E-08	5.08E-07	2.63E-06

Table 3. ENERGY LEVELS AND EQUILIBRIUM FRACTIONAL ELECTRONIC POPULATIONS OF C

STATE	LEVEL (CM-1)	LEVEL (EV)	STAT. WT.	200	250	300	TEMPERATURE (CEG K) 400	500	600	800	1000	1500
2s 2p ² ³ P ₀ ³ P ₁ ³ P ₂ ¹ D ₂ ¹ S	0	0.0000	1	1.37E-01	1.31E-01	1.28E-01	1.23E-01	1.21E-01	1.19E-01	1.17E-01	1.16E-01	1.14E-01
	16	0.0020	3	3.64E-01	3.58E-01	3.54E-01	3.49E-01	3.46E-01	3.44E-01	3.41E-01	3.40E-01	3.38E-01
	43	0.0054	5	4.99E-01	5.11E-01	5.18E-01	5.28E-01	5.33E-01	5.37E-01	5.42E-01	5.44E-01	5.48E-01
	10194	1.2639	5	9.67E-03	2.18E-26	3.74E-22	7.34E-17	1.10E-13	1.44E-11	6.39E-09	2.47E-07	3.24E-05
	21648	2.6839	1	0.	0.	0.	1.88E-35	1.07E-28	3.40E-24	1.45E-18	3.45E-15	1.10E-10
2s 2p ² ³ S ₀ ³ D ₀ ³ P ₀ ³ S ₀ ¹ D ₀	33735	4.1825	5	0.	0.	0.	0.	0.	4.39E-36	2.62E-27	4.83E-22	5.06E-15
	64091	7.9461	15	0.	0.	0.	0.	0.	0.	0.	0.	3.43E-27
	75256	9.3303	5	0.	0.	0.	0.	0.	0.	0.	0.	4.60E-32
	105801	13.1173	3	0.	0.	0.	0.	0.	0.	0.	0.	0.
	97878*	12.1350	5	0.	0.	0.	0.	0.	0.	0.	0.	0.
2p ⁴ ¹ P ₀ ¹ P ₁ ¹ D ₀ ¹ S ₀ ³ P ₀ (2p ³) 3s	119878*	14.8626	3	0.	0.	0.	0.	0.	0.	0.	0.	0.
	150000*	18.5972	5	0.	0.	0.	0.	0.	0.	0.	0.	0.
	158000*	19.5890	5	0.	0.	0.	0.	0.	0.	0.	0.	0.
	181000*	22.4406	1	0.	0.	0.	0.	0.	0.	0.	0.	0.
	60776	7.5351	12	0.	0.	0.	0.	0.	0.	0.	1.47E-38	6.60E-26
2s 2p ² ³ P ₀ ³ P ₁ ³ P ₂ ¹ D ₂ ¹ S	69722	8.6442	36	0.	0.	0.	0.	0.	0.	0.	0.	3.72E-29
	78426	9.7233	60	0.	0.	0.	0.	0.	0.	0.	0.	1.47E-32
	78184	9.6933	12	0.	0.	0.	0.	0.	0.	0.	0.	3.70E-33
	80866	10.0258	36	0.	0.	0.	0.	0.	0.	0.	0.	8.47E-34
	83850*	10.3458	60	0.	0.	0.	0.	0.	0.	0.	0.	8.06E-35
2s 2p ² ³ P ₀ ³ P ₁ ³ P ₂ ¹ D ₂ ¹ S	84000*	10.4144	84	0.	0.	0.	0.	0.	0.	0.	0.	9.78E-35
	116000*	14.3818	24	0.	0.	0.	0.	0.	0.	0.	0.	0.
	125000*	15.4976	72	0.	0.	0.	0.	0.	0.	0.	0.	0.
	132000*	16.3655	120	0.	0.	0.	0.	0.	0.	0.	0.	0.
	136169*	16.8824	24	0.	0.	0.	0.	0.	0.	0.	0.	0.
2s 2p ² ³ D ₀ ³ P ₀ ³ D ₁ ³ D ₂ ¹ P ₀ (2p ³) 3	138000*	17.1044	24	0.	0.	0.	0.	0.	0.	0.	0.	0.
	145000*	17.9772	60	0.	0.	0.	0.	0.	0.	0.	0.	0.
	154000*	19.0931	100	0.	0.	0.	0.	0.	0.	0.	0.	0.
	158000*	19.5890	320	0.	0.	0.	0.	0.	0.	0.	0.	0.
	184000*	22.8125	108	0.	0.	0.	0.	0.	0.	0.	0.	0.
2p ³ ⁴ S ₀ ⁴ P ₀ ⁴ P ₁ ⁴ P ₂ ² D ₀ (2p ²) 3	24.0523	24.0523	192	0.	0.	0.	0.	0.	0.	0.	0.	0.
	21.0768	21.0768	36	0.	0.	0.	0.	0.	0.	0.	0.	0.
	22.1926	22.1926	64	0.	0.	0.	0.	0.	0.	0.	0.	0.
	26.7799	26.7799	72	0.	0.	0.	0.	0.	0.	0.	0.	0.
	27.8957	27.8957	128	0.	0.	0.	0.	0.	0.	0.	0.	0.
2p ³ ² D ₀ ² D ₁ ² D ₂ ² P ₀ ² P ₁	27.7717	27.7717	180	0.	0.	0.	0.	0.	0.	0.	0.	0.
	28.8876	28.8876	320	0.	0.	0.	0.	0.	0.	0.	0.	0.
	30.1274	30.1274	108	0.	0.	0.	0.	0.	0.	0.	0.	0.
	31.2432	31.2432	192	0.	0.	0.	0.	0.	0.	0.	0.	0.
	252000*	25.2000	192	0.	0.	0.	0.	0.	0.	0.	0.	0.

*ESTIMATED.
 **INCLUDES ESTIMATED SUBLEVELS.
 ACNSTARRED ENERGY LEVELS FROM MUELLER (3) AND MINNAGHAN (38).
 NOTE: STATES INVOLVING ELECTRONS WITH PRINCIPAL QUANTUM NUMBERS ABOVE N = 4 ARE NOT INCLUDED.
 ALL LEVELS ABOVE 90814 CM-1 ARE SUBJECT TO AUTOCORRELATION.

Table 3 (Cont.). ENERGY LEVELS AND EQUILIBRIUM FRACTIONAL ELECTRONIC POPULATIONS OF C

LEVEL (CM-1)	2000	2500	3000	3500	4000	4500	5000	6000	7000	8000	9000	10000
0	1.13E-01	1.13E-01	1.12E-01	1.12E-01	1.11E-01	1.10E-01	1.09E-01	1.07E-01	1.04E-01	1.02E-01	1.00E-01	9.80E-02
16	3.36E-01	3.35E-01	3.34E-01	3.32E-01	3.30E-01	3.28E-01	3.25E-01	3.19E-01	3.12E-01	3.06E-01	2.99E-01	2.93E-01
43	5.50E-01	5.50E-01	5.50E-01	5.48E-01	5.45E-01	5.41E-01	5.37E-01	5.28E-01	5.17E-01	5.07E-01	4.97E-01	4.87E-01
10194	3.71E-04	1.60E-03	4.22E-03	8.44E-03	1.41E-02	2.11E-02	2.89E-02	4.63E-02	6.42E-02	8.17E-02	9.81E-02	1.13E-01
21648	1.96E-08	4.38E-07	3.48E-06	1.52E-05	4.60E-05	1.08E-04	2.14E-04	5.94E-04	1.22E-03	2.08E-03	3.14E-03	4.35E-03
33735	1.64E-11	2.09E-09	5.28E-08	5.29E-07	2.97E-06	1.14E-05	3.31E-05	1.64E-04	5.09E-04	1.18E-03	2.28E-03	3.82E-03
64091	1.61E-20	1.62E-16	7.53E-14	6.04E-12	1.62E-10	2.08E-09	1.60E-08	3.38E-07	2.98E-06	1.51E-05	5.33E-05	1.45E-04
75256	3.14E-24	1.57E-19	2.14E-16	3.68E-14	1.75E-12	3.51E-11	3.85E-10	1.40E-08	1.80E-07	1.22E-06	5.37E-06	1.75E-05
105801	3.00E-34	1.22E-27	3.09E-23	4.32E-21	9.85E-18	6.71E-16	1.96E-14	3.07E-12	1.13E-10	1.67E-09	1.35E-08	7.20E-08
97878	1.49E-31	1.94E-25	2.30E-21	1.87E-18	2.04E-16	1.41E-14	3.19E-13	3.42E-11	5.56E-10	1.16E-08	8.01E-08	3.75E-07
119878	1.20E-38	3.69E-31	3.62E-26	1.33E-22	6.23E-20	7.44E-18	3.41E-16	1.05E-13	6.24E-12	1.33E-10	1.43E-09	9.50E-09
150000	0.	3.27E-38	5.77E-32	1.67E-27	3.68E-24	1.47E-21	1.76E-19	2.29E-16	3.83E-14	1.77E-12	3.47E-11	3.74E-10
158000	0.	0.	6.92E-34	3.45E-29	1.15E-25	6.31E-23	9.77E-21	1.87E-17	4.11E-15	2.33E-13	5.36E-12	6.57E-11
181000	0.	0.	2.24E-39	5.41E-34	5.88E-30	8.08E-27	2.61E-24	1.51E-20	7.27E-18	7.45E-16	2.71E-14	4.80E-13
6077	1.40E-19	8.73E-16	2.95E-13	1.89E-11	4.26E-10	4.79E-09	3.32E-08	5.55E-07	4.71E-06	2.20E-05	7.24E-05	1.87E-04
69722	6.73E-22	1.52E-17	1.21E-14	1.43E-12	5.12E-11	8.23E-10	7.58E-09	2.10E-07	2.25E-06	1.32E-05	5.20E-05	1.55E-04
78426	2.14E-24	1.49E-19	3.11E-16	6.67E-14	3.72E-12	8.49E-11	1.03E-09	4.35E-08	6.25E-07	4.59E-06	2.15E-05	7.39E-05
78184	5.09E-25	3.89E-20	6.90E-17	1.47E-14	8.13E-13	1.83E-11	2.21E-10	9.22E-09	1.31E-07	9.59E-07	4.48E-06	1.53E-05
80866	2.22E-25	2.49E-20	5.80E-17	1.47E-14	9.29E-13	2.33E-11	3.07E-10	1.43E-08	2.27E-07	1.78E-06	8.75E-06	3.12E-05
83850	4.32E-26	7.46E-21	2.31E-17	7.17E-15	5.29E-13	1.50E-11	2.17E-10	1.18E-08	2.05E-07	1.73E-06	9.05E-06	3.39E-05
84000	5.43E-26	9.58E-21	3.01E-17	9.44E-15	7.02E-13	2.00E-11	2.91E-10	1.60E-08	2.78E-07	2.36E-06	1.24E-05	4.64E-05
116000	1.56E-36	2.75E-29	1.86E-24	5.22E-21	2.01E-18	2.06E-16	8.32E-15	2.13E-12	1.11E-10	2.13E-09	2.12E-08	1.33E-07
125000	0.	4.64E-31	7.44E-26	3.88E-22	2.37E-19	3.47E-17	1.87E-15	7.37E-13	5.22E-11	1.27E-09	1.51E-08	1.09E-07
132000	0.	1.38E-32	4.32E-27	3.63E-23	3.18E-20	6.17E-18	4.16E-16	2.29E-13	2.06E-11	6.00E-10	8.22E-09	6.64E-08
136169	0.	2.50E-34	1.17E-28	1.31E-24	1.42E-21	3.26E-19	2.51E-17	1.69E-14	1.75E-12	5.67E-11	8.44E-10	7.29E-09
138000	0.	7.27E-35	4.05E-29	5.14E-25	6.13E-22	1.51E-19	1.23E-17	9.06E-15	1.00E-12	3.40E-11	5.25E-10	4.67E-09
145000	0.	3.88E-36	4.23E-30	8.68E-26	1.48E-22	4.83E-20	4.94E-18	5.07E-15	7.14E-13	2.90E-11	5.14E-10	5.12E-09
154000	0.	3.64E-38	9.42E-32	3.58E-27	9.71E-24	4.53E-21	6.18E-19	9.77E-16	1.57E-13	9.57E-12	2.03E-10	2.34E-09
158000	0.	0.	4.43E-32	2.21E-27	7.37E-24	4.04E-21	6.25E-19	1.20E-15	2.63E-13	1.49E-11	3.43E-10	4.20E-09
184000	0.	0.	5.74E-38	1.70E-32	2.16E-28	3.34E-25	1.19E-22	7.93E-19	4.24E-16	4.69E-14	1.81E-12	3.37E-11
194000	0.	0.	0.	4.96E-34	1.05E-29	2.43E-26	1.13E-23	1.28E-19	5.65E-17	1.38E-14	6.52E-13	1.42E-11
170000	0.	0.	1.58E-35	1.79E-30	1.11E-26	9.80E-24	2.23E-21	7.58E-18	2.51E-15	1.94E-13	5.67E-12	8.41E-11
175000	0.	0.	7.73E-37	7.88E-32	7.73E-28	9.80E-25	2.97E-22	1.56E-18	7.02E-16	6.83E-14	2.39E-12	4.10E-11
216000	0.	0.	0.	2.20E-38	1.44E-33	8.03E-30	7.94E-27	2.46E-22	3.93E-19	5.90E-17	7.26E-15	2.25E-13
225000	0.	0.	0.	0.	1.01E-34	8.03E-31	1.06E-27	5.03E-23	1.10E-19	3.49E-17	3.06E-15	1.09E-13
224000	0.	0.	0.	0.	2.03E-34	1.56E-30	1.99E-27	9.02E-23	1.90E-19	5.87E-17	5.05E-15	1.78E-13
233000	0.	0.	0.	0.	1.42E-35	1.56E-31	2.65E-28	1.85E-23	5.31E-20	2.07E-17	2.13E-15	8.65E-14
243000	0.	0.	0.	0.	1.31E-37	2.15E-33	5.03E-30	5.68E-25	2.29E-21	1.16E-18	1.45E-16	6.93E-15
252000	0.	0.	0.	0.	0.	2.15E-34	6.71E-31	1.17E-25	6.41E-22	4.07E-19	6.13E-17	3.37E-15

Table 4. ENERGY LEVELS AND EQUILIBRIUM FRACTIONAL ELECTRONIC POPULATIONS OF C⁺

STATE	LEVEL (CM-1)	LEVEL (EV)	STAT. WT.	200	250	300	400	500	600	800	1000	1500
2s ² 2p ¹ P ₂ ^o	0	0.0000	2	4.42E-01	4.20E-01	4.05E-01	3.86E-01	3.75E-01	3.68E-01	3.59E-01	3.54E-01	3.47E-01
2s ² 2p ¹ P ₂ ^o	64	0.0079	4	5.38E-01	5.80E-01	5.95E-01	6.14E-01	6.25E-01	6.32E-01	6.41E-01	6.46E-01	6.53E-01
2s ² 2p ¹ P ₂ ^o	43033	5.3353	12	0.	0.	0.	0.	0.	0.	0.	0.	0.
2s ² 2p ¹ P ₂ ^o	74932	9.2901	10	0.	0.	0.	0.	0.	0.	0.	0.	0.
2s ² 2p ¹ P ₂ ^o	96494	11.9634	2	0.	0.	0.	0.	0.	0.	0.	0.	0.
2s ² 2p ¹ P ₂ ^o	110653	13.7189	6	0.	0.	0.	0.	0.	0.	0.	0.	0.
2s ² 2p ¹ P ₂ ^o	142024	17.6083	4	0.	0.	0.	0.	0.	0.	0.	0.	0.
2s ² 2p ¹ P ₂ ^o	150465	18.6548	10	0.	0.	0.	0.	0.	0.	0.	0.	0.
2s ² 2p ¹ P ₂ ^o	168744	20.5210	6	0.	0.	0.	0.	0.	0.	0.	0.	0.
2s ² 2p ¹ P ₂ ^o	116538	14.4485	2	0.	0.	0.	0.	0.	0.	0.	0.	0.
3s	131725	16.3314	6	0.	0.	0.	0.	0.	0.	0.	0.	0.
3p	145550	18.0454	10	0.	0.	0.	0.	0.	0.	0.	0.	0.
3d	157235	19.4942	2	0.	0.	0.	0.	0.	0.	0.	0.	0.
4s	162523	20.1498	6	0.	0.	0.	0.	0.	0.	0.	0.	0.
4p	168125	20.8443	10	0.	0.	0.	0.	0.	0.	0.	0.	0.
4d	168979	20.9502	14	0.	0.	0.	0.	0.	0.	0.	0.	0.
4f	170643	21.1565	18	0.	0.	0.	0.	0.	0.	0.	0.	0.
5s	184786	22.9100	54	0.	0.	0.	0.	0.	0.	0.	0.	0.
5p	197747	24.5163	90	0.	0.	0.	0.	0.	0.	0.	0.	0.
5d	210000**	26.0360	18	0.	0.	0.	0.	0.	0.	0.	0.	0.
5f	215730**	26.7464	54	0.	0.	0.	0.	0.	0.	0.	0.	0.
6s	220465	27.3335	90	0.	0.	0.	0.	0.	0.	0.	0.	0.
6p	221458	27.4566	126	0.	0.	0.	0.	0.	0.	0.	0.	0.
6d	219000*	27.1518	6	0.	0.	0.	0.	0.	0.	0.	0.	0.
6f	234000*	29.0116	18	0.	0.	0.	0.	0.	0.	0.	0.	0.
7s	246000*	30.4993	30	0.	0.	0.	0.	0.	0.	0.	0.	0.
7p	260000*	32.2351	6	0.	0.	0.	0.	0.	0.	0.	0.	0.
7d	265000*	32.8550	18	0.	0.	0.	0.	0.	0.	0.	0.	0.
7f	270000*	33.5369	30	0.	0.	0.	0.	0.	0.	0.	0.	0.
8s	271400*	33.6484	42	0.	0.	0.	0.	0.	0.	0.	0.	0.
8p	257000*	31.8631	18	0.	0.	0.	0.	0.	0.	0.	0.	0.
8d	271500*	33.5989	54	0.	0.	0.	0.	0.	0.	0.	0.	0.
8f	283000*	35.0866	90	0.	0.	0.	0.	0.	0.	0.	0.	0.
9s	304500*	37.7522	288	0.	0.	0.	0.	0.	0.	0.	0.	0.
9p	267000*	33.1029	10	0.	0.	0.	0.	0.	0.	0.	0.	0.
9d	281000*	34.8387	30	0.	0.	0.	0.	0.	0.	0.	0.	0.
9f	292000*	36.2025	50	0.	0.	0.	0.	0.	0.	0.	0.	0.
10s	313000*	38.8061	160	0.	0.	0.	0.	0.	0.	0.	0.	0.
10p	315000*	39.5499	18	0.	0.	0.	0.	0.	0.	0.	0.	0.
10d	349000*	43.2494	32	0.	0.	0.	0.	0.	0.	0.	0.	0.

*ESTIMATED.

**INCLUDES ESTIMATED SUBLEVELS.

***UNSTARRED ENERGY LEVELS FROM PCORE (3) AND GLAD (39).

NOTE: STATES INVOLVING ELECTRONS WITH PRINCIPAL QUANTUM NUMBERS ABOVE N = 4 ARE NOT INCLUDED.

ALL LEVELS ABOVE 196059 CM-1 ARE SUBJECT TO AUTOCORRECTION.

Table 4 (Cont.). ENERGY LEVELS AND EQUILIBRIUM FRACTIONAL ELECTRONIC POPULATIONS OF C⁺

LEVEL (CM ⁻¹)	TEMPERATURE (DEG K)												
	2000	2500	3000	3500	4000	4500	5000	6000	7000	8000	9000	10000	
C	3.44E-01	3.42E-01	3.40E-01	3.39E-01	3.38E-01	3.38E-01	3.37E-01	3.37E-01	3.36E-01	3.36E-01	3.35E-01	3.34E-01	
61	6.56E-01	6.58E-01	6.60E-01	6.61E-01	6.62E-01	6.62E-01	6.63E-01	6.63E-01	6.64E-01	6.64E-01	6.63E-01	6.62E-01	
43033	7.40E-14	3.60E-11	2.22E-09	4.23E-08	3.85E-07	2.15E-06	8.48E-06	6.61E-05	6.64E-01	2.77E-04	2.07E-03	4.10E-03	
74932	6.67E-24	3.19E-19	4.20E-16	7.11E-14	3.33E-12	6.65E-11	7.29E-10	2.65E-08	3.44E-07	8.36E-06	1.05E-05	3.47E-05	
96494	2.45E-31	2.60E-25	2.71E-21	2.01E-18	2.86E-16	1.35E-14	2.95E-13	3.01E-11	8.18E-10	9.75E-09	6.69E-08	3.12E-07	
1110653	2.77E-35	2.26E-28	9.15E-24	1.79E-20	5.26E-18	4.37E-16	1.50E-14	3.02E-12	1.34E-10	2.29E-09	2.09E-08	1.22E-07	
142024	0.	2.17E-36	1.78E-30	2.99E-26	4.41E-23	1.28E-20	1.20E-18	1.05E-15	1.41E-13	5.42E-12	9.23E-11	8.92E-10	
150465	C.	4.21E-38	7.78E-32	2.33E-27	5.29E-24	2.16E-21	2.65E-19	3.60E-16	6.23E-14	2.97E-12	5.93E-11	6.62E-10	
168744	0.	0.	7.27E-36	7.61E-31	4.43E-27	3.75E-24	8.26E-22	2.70E-18	8.72E-16	6.65E-14	1.93E-12	2.86E-11	
116538	1.34E-37	2.54E-30	1.81E-25	5.31E-22	2.11E-19	2.22E-17	9.21E-16	2.46E-13	1.33E-11	2.65E-10	2.72E-09	1.74E-08	
131725	0.	1.22E-33	3.74E-28	3.09E-24	2.65E-21	5.19E-19	3.49E-17	1.93E-14	1.76E-12	5.18E-11	7.19E-10	5.89E-09	
145550	0.	7.13E-37	8.22E-31	1.75E-26	3.10E-23	1.04E-20	1.09E-18	1.17E-15	1.71E-13	7.18E-12	1.31E-10	1.34E-09	
157235	C.	0.	6.05E-34	2.88E-29	9.27E-26	4.96E-23	7.56E-21	1.42E-17	3.10E-15	1.76E-13	4.06E-12	5.00E-11	
162523	0.	0.	1.44E-34	9.82E-30	4.15E-26	2.74E-23	4.95E-21	1.20E-17	2.13E-15	2.04E-13	2.23E-12	7.01E-11	
168125	0.	C.	1.63E-35	1.64E-30	9.22E-27	7.63E-24	1.65E-21	5.31E-18	1.65E-15	1.24E-13	3.56E-12	5.22E-11	
168979	C.	0.	1.52E-35	1.61E-30	9.50E-27	8.13E-24	1.80E-21	5.95E-18	1.94E-15	1.49E-13	4.35E-12	6.48E-11	
170643	0.	0.	8.78E-36	1.05E-30	6.71E-27	6.14E-24	1.44E-21	5.13E-18	1.77E-15	1.42E-13	4.28E-12	6.53E-11	
184786	0.	0.	2.98E-38	9.37E-33	1.24E-28	2.00E-25	7.35E-23	5.18E-19	2.90E-16	3.34E-14	1.34E-12	2.56E-11	
197742	0.	0.	C.	7.60E-35	1.94E-30	5.30E-27	2.95E-24	3.86E-20	3.37E-17	5.42E-15	2.81E-13	6.62E-12	
211000	0.	0.	0.	9.84E-38	4.77E-33	2.10E-29	1.73E-26	4.09E-22	5.43E-19	1.20E-16	7.93E-15	2.27E-13	
215730	0.	0.	0.	2.80E-38	1.82E-33	1.01E-29	9.59E-27	3.10E-22	5.02E-19	1.28E-16	9.52E-15	2.99E-13	
220465	0.	0.	0.	C.	5.53E-34	3.70E-30	4.26E-27	1.66E-22	3.16E-19	9.10E-17	7.44E-15	2.52E-13	
221458	0.	0.	0.	C.	5.42E-34	3.78E-30	4.48E-27	1.83E-22	3.61E-19	1.07E-16	8.89E-15	3.06E-13	
219000	0.	0.	0.	0.	6.25E-35	3.55E-31	4.33E-28	1.57E-23	2.85E-20	7.90E-18	6.27E-16	2.07E-14	
234000	0.	0.	0.	0.	8.50E-37	9.78E-33	1.73E-29	1.29E-24	3.91E-21	1.60E-18	1.71E-16	7.18E-15	
246000	0.	0.	0.	0.	1.89E-38	3.52E-34	9.15E-31	1.21E-25	5.54E-22	3.07E-19	4.10E-17	2.13E-15	
250000	0.	0.	0.	0.	0.	8.00E-37	3.26E-33	8.46E-28	6.23E-24	4.95E-21	8.92E-19	5.68E-17	
265000	0.	0.	0.	0.	0.	4.85E-37	2.32E-33	7.65E-28	6.69E-24	6.05E-21	1.20E-18	8.30E-17	
270500	0.	0.	0.	0.	0.	1.39E-37	7.93E-34	3.41E-28	3.60E-24	3.75E-21	8.33E-19	6.27E-17	
271500	0.	0.	0.	0.	0.	1.46E-37	8.57E-34	3.85E-28	4.19E-24	4.46E-21	1.01E-18	7.11E-17	
286000	0.	0.	0.	0.	C.	6.26E-36	2.32E-32	5.21E-27	3.41E-23	2.55E-20	4.33E-18	2.62E-16	
271000	0.	0.	0.	0.	0.	2.14E-37	1.24E-33	5.44E-28	1.85E-24	6.17E-21	1.38E-18	1.05E-16	
283000	0.	0.	0.	0.	0.	0.	6.52E-35	5.11E-29	8.27E-25	1.11E-21	3.39E-19	3.11E-17	
304500	0.	0.	0.	0.	0.	0.	4.29E-37	9.42E-31	3.19E-26	7.95E-23	3.49E-20	4.52E-18	
267000	0.	0.	0.	0.	0.	0.	7.24E-34	2.63E-28	2.46E-24	2.34E-21	4.86E-19	3.46E-17	
281000	0.	0.	0.	0.	0.	C.	3.87E-35	2.75E-29	4.16E-25	5.67E-22	1.55E-19	1.38E-17	
292000	0.	0.	0.	C.	0.	0.	2.72E-36	3.28E-30	7.23E-26	1.31E-22	4.46E-20	4.74E-18	
313000	0.	0.	0.	0.	0.	0.	6.82E-32	3.09E-27	3.09E-27	9.58E-24	4.98E-21	7.39E-19	
315000	0.	C.	C.	0.	0.	0.	1.82E-33	1.01E-28	1.01E-28	3.66E-25	2.14E-22	3.51E-20	
345000	C.	0.	0.	0.	0.	0.	0.	2.43E-36	3.78E-31	2.95E-27	3.15E-24	8.32E-22	

Table 5. ENERGY LEVELS AND EQUILIBRIUM FRACTIONAL ELECTRONIC POPULATIONS OF N

STATE	LEVEL (CM-1)	LEVEL (EV)	STAT. WT.	200	250	300	400	500	600	800	1000	1500
2s ² 2p ³ 5°	G	0.0000	4	1.00E 00	1.00E 00	1.00E 00	1.00E 00	1.00E 00	1.00E 00	1.00E 00	1.00E 00	1.00E 00
2s ² 2p ³ 1D°	1922E	2.3839	10	0.	0.	0.	0.	0.	0.	0.	0.	0.
2s ² 2p ³ 3P°	28839	3.5755	6	0.	0.	0.	0.	0.	0.	0.	0.	0.
2s ² 2p ³ 1P°	88132	10.9267	12	0.	0.	0.	0.	0.	0.	0.	0.	0.
2s ² 2p ³ 3D	121000*	15.0017	10	0.	0.	0.	0.	0.	0.	0.	0.	0.
2s ² 2p ³ 5S	142110*	17.6189	2	0.	0.	0.	0.	0.	0.	0.	0.	0.
2s ² 2p ³ 3P	158200*	19.6138	6	0.	0.	0.	0.	0.	0.	0.	0.	0.
2s ² 2p ³ 1P°	232900*	28.8752	6	0.	0.	0.	0.	0.	0.	0.	0.	0.
2s ² 2p ³ (P) 3s	84288	10.4501	18	0.	0.	0.	0.	0.	0.	0.	0.	0.
2s ² 2p ³ (P) 3p	95780	11.8749	54	0.	0.	0.	0.	0.	0.	0.	0.	0.
3d	104861	13.0008	90	0.	0.	0.	0.	0.	0.	0.	0.	0.
4s	103861	12.8768	18	0.	0.	0.	0.	0.	0.	0.	0.	0.
4p	107420**	13.3180	54	0.	0.	0.	0.	0.	0.	0.	0.	0.
4d	110315	13.6770	90	0.	0.	0.	0.	0.	0.	0.	0.	0.
4f	110441	13.6926	126	0.	0.	0.	0.	0.	0.	0.	0.	0.
(D) 3s	99664	12.3564	10	0.	0.	0.	0.	0.	0.	0.	0.	0.
(D) 3p	110973	13.7585	30	0.	0.	0.	0.	0.	0.	0.	0.	0.
3d	121000**	15.0017	50	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	124600**	15.4480	160	0.	0.	0.	0.	0.	0.	0.	0.	0.
(S) 3s	116279	14.4164	2	0.	0.	0.	0.	0.	0.	0.	0.	0.
3p	128400*	15.9192	6	0.	0.	0.	0.	0.	0.	0.	0.	0.
3d	137500*	17.0474	10	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	142000*	17.6053	32	0.	0.	0.	0.	0.	0.	0.	0.	0.
2s ² 2p ³ (S°) 3	153000*	18.9691	90	0.	0.	0.	0.	0.	0.	0.	0.	0.
2s ² 2p ³ (S°) 4	156000*	19.3410	120	0.	0.	0.	0.	0.	0.	0.	0.	0.
(D°) 3	192000*	23.8044	270	0.	0.	0.	0.	0.	0.	0.	0.	0.
(P°) 3-4	202000*	25.0442	480	0.	0.	0.	0.	0.	0.	0.	0.	0.
(S°) 3-4	215000*	26.6559	450	0.	0.	0.	0.	0.	0.	0.	0.	0.
(S°) 3-4	259000*	32.1111	550	0.	0.	0.	0.	0.	0.	0.	0.	0.
2p ³ (P,D,S) 3-4	331000*	41.0377	750	0.	0.	0.	0.	0.	0.	0.	0.	0.

*ESTIMATED.

**INCLUDES ESTIMATED SUBLEVELS.

†NONSTARRED ENERGY LEVELS FROM MOORE (13) ERIKSSON (40) AND ERIKSSON AND JOHANSSON (41).

‡STATES INVOLVING ELECTRONS WITH PRINCIPAL QUANTUM NUMBERS ABOVE N = 4 ARE NOT INCLUDED.

ALL LEVELS ABOVE 117214 CM-1 ARE SUBJECT TO AUTOCORRECTION.

Table 5 (Cont.). ENERGY LEVELS AND EQUILIBRIUM FRACTIONAL ELECTRONIC POPULATIONS OF N

LEVEL (cm ⁻¹)	TEMPERATURE (DEG K)											
	2000	2500	3000	3500	4000	4500	5000	6000	7000	8000	9000	10000
C	1.00E-00	1.00E-00	1.00E-00	9.99E-01	9.97E-01	9.95E-01	9.90E-01	9.74E-01	9.51E-01	9.20E-01	8.85E-01	8.47E-01
1022A	2.46E-06	3.91E-05	2.47E-04	9.22E-04	2.47E-03	5.32E-03	9.78E-03	2.42E-02	4.57E-02	7.24E-02	1.02E-01	1.33E-01
26839	1.47E-09	9.29E-08	1.48E-06	1.06E-05	4.68E-05	1.48E-04	5.69E-04	1.45E-03	3.80E-03	7.71E-03	1.32E-02	2.00E-02
26132	8.75E-28	2.81E-22	1.32E-18	5.53E-16	5.11E-14	1.73E-12	2.88E-11	1.94E-09	3.87E-08	3.61E-07	2.02E-06	7.90E-06
1210CC	3.93E-38	1.43E-30	1.57E-25	6.24E-22	3.13E-19	3.92E-17	1.87E-15	6.10E-13	3.76E-11	8.14E-10	8.79E-09	5.82E-08
142110	0.	1.51E-36	1.26E-30	2.13E-26	3.11E-23	9.20E-21	8.61E-19	7.73E-16	9.80E-15	3.65E-12	6.01E-11	5.58E-10
158200	0.	0.	1.68E-33	8.55E-29	2.90E-25	1.61E-22	2.52E-20	4.69E-17	1.08E-14	6.07E-13	1.38E-11	1.45E-10
232900	0.	0.	0.	0.	6.20E-37	6.82E-33	1.16E-29	8.13E-25	2.31E-21	8.88E-19	8.97E-17	3.56E-15
84288	2.09E-26	3.85E-21	1.25E-17	4.03E-15	3.06E-13	8.85E-12	1.30E-10	7.31E-09	1.28E-07	1.08E-06	5.60E-06	2.06E-05
55780	1.61E-29	1.55E-23	1.52E-19	1.07E-16	1.47E-14	6.73E-13	1.49E-11	1.39E-09	3.62E-08	4.10E-07	2.57E-06	1.18E-05
104861	3.90E-32	1.39E-25	3.24E-21	4.27E-18	9.34E-16	6.15E-14	1.75E-12	2.63E-10	5.33E-09	1.34E-07	1.04E-06	5.34E-06
103861	1.60E-32	4.94E-26	1.05E-21	1.29E-18	2.68E-16	1.69E-14	4.67E-13	6.69E-11	2.29E-09	3.20E-08	2.45E-07	1.23E-06
107420	3.71E-33	1.91E-26	5.70E-22	8.96E-19	2.23E-16	1.63E-14	5.03E-13	8.55E-11	3.31E-09	5.06E-08	4.16E-07	2.22E-06
110315	7.70E-34	6.02E-27	2.37E-22	4.54E-19	1.31E-16	1.08E-14	3.65E-13	7.12E-11	3.04E-09	5.01E-08	4.36E-07	2.44E-06
110441	9.85E-34	7.84E-27	3.13E-22	6.04E-19	1.76E-16	1.45E-14	4.92E-13	9.67E-11	4.15E-09	6.85E-08	5.99E-07	3.35E-06
59664	1.82E-31	3.07E-25	4.36E-21	4.02E-18	6.73E-16	3.60E-14	8.68E-13	1.02E-10	3.02E-09	3.18E-08	2.66E-07	1.25E-06
110973	1.60E-34	1.37E-27	5.77E-23	1.15E-19	3.45E-17	2.91E-15	1.00E-13	2.03E-11	6.55E-10	1.48E-08	1.31E-07	7.35E-07
1210CC	1.96E-37	7.14E-30	7.84E-25	3.12E-21	1.56E-18	1.96E-16	9.35E-15	3.05E-12	1.88E-10	4.07E-09	4.39E-08	2.91E-07
124600	0.	2.88E-30	4.46E-25	2.27E-21	1.37E-18	1.59E-16	1.06E-14	4.12E-12	2.87E-10	6.82E-09	7.91E-08	5.55E-07
116279	2.34E-37	4.32E-30	3.02E-25	8.69E-22	3.42E-19	3.55E-17	1.46E-15	3.78E-13	1.98E-11	3.81E-10	3.74E-09	2.30E-08
128400	0.	1.21E-32	2.70E-27	1.79E-23	1.31E-20	2.21E-18	1.33E-16	6.21E-14	4.92E-12	1.29E-10	1.61E-09	1.20E-08
137500	0.	1.07E-34	5.73E-29	7.07E-25	8.27E-22	2.01E-19	1.62E-17	1.17E-14	1.26E-12	4.19E-11	6.28E-10	5.42E-09
142000	0.	2.58E-35	2.12E-29	3.56E-25	5.24E-22	1.52E-19	1.42E-17	1.27E-14	1.60E-12	5.96E-11	9.79E-10	9.08E-09
153000	0.	1.29E-37	3.05E-31	1.09E-26	2.82E-23	1.27E-20	1.69E-18	2.55E-15	4.70E-13	2.32E-11	4.75E-10	5.24E-09
155000	0.	0.	1.29E-31	5.63E-27	1.70E-23	8.67E-21	1.26E-18	2.21E-15	4.51E-13	2.40E-11	5.22E-10	6.05E-09
152000	0.	0.	0.	3.56E-33	6.84E-29	1.47E-25	6.77E-23	6.65E-19	4.66E-16	6.26E-14	2.79E-12	5.75E-11
202000	0.	0.	0.	1.04E-34	3.33E-30	1.07E-26	6.77E-24	1.07E-19	1.06E-16	1.84E-14	1.00E-12	2.43E-11
215000	0.	0.	0.	4.64E-37	2.91E-32	1.56E-28	1.51E-25	4.46E-21	6.87E-18	1.67E-15	1.18E-13	3.50E-12
255000	0.	0.	0.	0.	0.	1.49E-34	5.84E-31	1.43E-25	9.92E-22	7.45E-19	1.27E-16	7.63E-15
331000	0.	0.	0.	0.	0.	0.	0.	6.17E-33	5.06E-28	2.42E-24	1.73E-21	3.30E-19

Table 6. ENERGY LEVELS AND EQUILIBRIUM FRACTIONAL ELECTRONIC POPULATIONS OF N

STATE	LEVEL (CP-1)	LEVEL (EV)	STAT. WT.	TEMPERATURE (OEG K)	1500	1000	800	600	500	400	300	250	200
2s 2p ² P ^o	0	0.0000	1	1.97E-01	1.78E-01	1.65E-01	1.51E-01	1.42E-01	1.37E-01	1.30E-01	1.26E-01	1.21E-01	1.21E-01
2s 2p ² P ^o	48.7	0.0060	3	4.17E-01	4.03E-01	3.93E-01	3.79E-01	3.70E-01	3.65E-01	3.57E-01	3.52E-01	3.46E-01	3.46E-01
2s 2p ² P ^o	130.8	0.0162	5	1.85E-01	4.15E-01	4.42E-01	4.70E-01	4.87E-01	4.99E-01	5.13E-01	5.22E-01	5.33E-01	5.33E-01
2s 2p ² P ^o	15316	1.8984	5	0.	0.	1.04E-32	8.93E-25	5.14E-20	7.65E-17	7.07E-13	1.69E-10	2.52E-07	2.52E-07
2s 2p ² P ^o	32589	4.0528	1	0.	0.	0.	0.	0.	1.4E-35	3.81E-27	4.72E-22	2.92E-15	2.92E-15
2s 2p ² S ^o	46785	5.0005	5	0.	0.	0.	0.	0.	0.	1.86E-37	3.67E-30	1.56E-20	1.56E-20
2s 2p ² S ^o	92245	11.4366	15	0.	0.	0.	0.	0.	0.	0.	0.	6.79E-39	6.79E-39
2s 2p ² S ^o	109218	13.5410	9	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2s 2p ² S ^o	155127	19.2328	3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2s 2p ² S ^o	144188	17.8766	5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2s 2p ² P ^o	166766	20.6758	3	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2s 2p ² P ^o	218000*	27.0279	9	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2s 2p ² P ^o	229000*	28.3916	5	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2s 2p ² P ^o	264000*	32.7310	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2s 2p ² P ^o	149056	18.4801	12	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3p	169022	20.9555	36	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3d	187693	23.2704	60	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4s	196555	24.4187	12	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4p	203384	25.2158	36	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4d	210284	26.0712	60	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4f	211271	26.1936	84	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2s 2p ² (P ^o) 3s	207974	25.7848	24	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3p	226455	28.0761	72	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3d	244500	30.3134	120	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	266100	32.5913	384	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2s 2p ² (D ^o) 3s	252000	31.2432	20	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3p	270000	33.4749	60	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3d	288000	35.7065	100	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
(P ^o) 3	309800	38.4092	320	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	323100	40.0583	108	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	354800	43.9885	192	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
(S ^o) 3	308100	38.1985	36	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	335800	42.1287	64	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2p ² (S ^o) 3	364000	45.1291	72	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	396000	49.0965	128	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
(D ^o) 3	380000	47.1124	180	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	412000	51.0002	320	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
(P ^o) 3	408000	50.5842	108	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4	439000	54.4277	192	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

*ESTIMATED.
ENERGY LEVELS FROM PCORE (3) AND ERIKSSON (42).
NOTE: STATES INVOLVING ELECTRONS WITH PRINCIPAL QUANTUM NUMBERS ABOVE N = 4 ARE NOT INCLUDED.
ALL LEVELS ABOVE 238751 CP-1 ARE SUBJECT TO AUTOIONIZATION.

Table 6 (Cont.). ENERGY LEVELS AND EQUILIBRIUM FRACTIONAL ELECTRONIC POPULATIONS OF N⁺

LEVEL (CM-1)	TEMPERATURE (DEG K)												
	2000	2500	3000	3500	4000	4500	5000	6000	7000	8000	9000	10000	
C	1.18E-01	1.17E-01	1.16E-01	1.15E-01	1.14E-01	1.14E-01	1.13E-01	1.12E-01	1.10E-01	1.09E-01	1.07E-01	1.06E-01	
48	3.43E-01	3.41E-01	3.40E-01	3.38E-01	3.37E-01	3.36E-01	3.35E-01	3.32E-01	3.28E-01	3.24E-01	3.20E-01	3.15E-01	
130	5.39E-01	5.42E-01	5.44E-01	5.45E-01	5.46E-01	5.46E-01	5.45E-01	5.42E-01	5.38E-01	5.32E-01	5.26E-01	5.19E-01	
15316	9.71E-06	8.68E-05	3.74E-04	1.06E-03	2.32E-03	4.25E-03	6.90E-03	1.42E-02	2.37E-02	3.47E-02	4.64E-02	5.84E-02	
32689	7.25E-12	7.90E-10	1.80E-08	1.68E-07	8.96E-07	3.25E-06	9.30E-06	4.41E-05	1.33E-04	3.05E-04	5.77E-04	9.59E-04	
46785	1.43E-15	1.18E-12	1.04E-10	2.56E-09	2.81E-08	1.81E-07	8.05E-07	7.51E-06	3.68E-05	1.21E-04	3.03E-04	6.31E-04	
92245	2.69E-29	1.54E-23	1.06E-19	5.87E-17	6.68E-15	2.65E-13	5.03E-12	4.15E-10	5.66E-09	1.02E-07	6.35E-07	2.73E-06	
104218	8.03E-35	5.29E-28	1.86E-23	3.27E-20	8.94E-18	6.59E-16	2.29E-14	4.25E-12	1.77E-10	2.89E-09	2.52E-08	1.43E-07	
155127	0.	0.	1.70E-33	6.97E-29	2.01E-25	9.84E-23	1.39E-20	2.35E-17	4.71E-15	2.50E-13	5.47E-12	6.43E-11	
144188	0.	5.34E-37	5.38E-31	1.04E-26	1.71E-23	5.41E-21	5.41E-19	5.39E-16	7.43E-14	2.98E-12	5.24E-11	5.17E-10	
166766	0.	0.	6.40E-36	5.83E-31	3.05E-27	2.38E-24	4.90E-22	1.44E-18	4.30E-16	3.08E-14	8.50E-13	1.21E-11	
218000	0.	0.	0.	0.	9.08E-35	5.49E-31	5.81E-28	1.99E-23	3.45E-20	9.20E-18	7.07E-16	2.27E-14	
225000	0.	0.	0.	0.	9.65E-37	9.05E-33	1.36E-29	7.92E-25	2.00E-21	7.07E-19	6.77E-17	2.60E-15	
264000	0.	0.	0.	0.	0.	2.50E-38	1.15E-34	3.59E-29	3.00E-25	2.61E-22	5.03E-20	3.37E-18	
149056	0.	7.79E-38	1.25E-31	3.38E-27	7.13E-24	2.74E-21	3.20E-19	4.03E-16	6.50E-14	2.98E-12	5.77E-11	6.16E-10	
165022	0.	0.	2.60E-35	2.77E-30	1.63E-26	1.39E-23	3.07E-21	1.01E-17	3.25E-15	2.46E-13	7.12E-12	1.05E-10	
187693	0.	0.	0.	2.14E-33	3.28E-29	5.91E-26	2.37E-23	1.91E-19	1.17E-16	1.43E-14	5.99E-13	1.19E-11	
196955	0.	0.	0.	9.50E-36	2.35E-31	6.12E-28	3.31E-25	4.13E-21	3.48E-18	5.40E-16	2.73E-14	6.26E-13	
203384	0.	0.	0.	2.03E-36	6.97E-32	2.35E-28	1.56E-25	2.65E-21	2.78E-18	5.10E-16	4.93E-14	7.45E-13	
210284	0.	0.	0.	1.98E-37	9.71E-33	4.31E-29	3.57E-26	8.46E-22	1.12E-18	2.46E-16	1.62E-14	4.60E-13	
211271	0.	0.	0.	1.85E-37	9.53E-33	4.40E-29	3.76E-26	9.35E-22	1.28E-18	2.88E-16	1.94E-14	5.59E-13	
207974	0.	0.	0.	2.05E-37	8.92E-33	3.61E-29	2.77E-26	5.55E-22	7.22E-19	1.49E-16	9.37E-15	2.57E-13	
226455	0.	0.	0.	3.47E-35	2.94E-31	4.08E-28	2.10E-23	4.85E-20	1.61E-17	1.46E-15	5.39E-14	5.39E-14	
244500	0.	0.	0.	8.78E-38	1.53E-33	3.78E-30	4.62E-25	1.98E-21	1.04E-18	1.36E-16	6.70E-15	6.70E-15	
266100	0.	0.	0.	0.	0.	4.90E-36	2.42E-32	8.33E-27	7.48E-23	6.87E-20	1.39E-17	9.58E-16	
252000	0.	0.	0.	0.	0.	2.32E-35	7.28E-32	1.28E-26	7.07E-23	4.52E-20	6.85E-18	3.79E-16	
270000	0.	0.	0.	0.	0.	2.20E-37	1.23E-33	5.11E-28	5.24E-24	5.33E-21	1.16E-18	8.54E-17	
280000	0.	0.	0.	0.	0.	0.	1.15E-35	1.14E-29	2.16E-25	3.79E-22	1.08E-19	1.07E-17	
309800	0.	0.	0.	0.	0.	0.	6.96E-38	1.95E-31	7.83E-27	2.21E-23	1.66E-20	1.48E-18	
323100	0.	0.	0.	0.	0.	0.	C.	2.71E-33	1.72E-28	6.83E-25	4.28E-22	7.39E-20	
354800	0.	0.	0.	0.	0.	0.	0.	2.41E-36	4.52E-31	4.06E-27	4.80E-24	1.37E-21	
308100	0.	0.	0.	0.	0.	0.	1.28E-38	3.30E-32	1.25E-27	3.38E-24	1.57E-21	2.13E-19	
335800	0.	0.	0.	0.	0.	0.	C.	2.93E-35	3.25E-30	2.01E-26	1.76E-23	3.96E-21	
364000	0.	0.	0.	0.	0.	0.	0.	9.95E-38	2.56E-32	2.91E-28	4.13E-25	1.37E-22	
356000	0.	0.	0.	0.	0.	0.	0.	0.	6.33E-35	1.64E-30	4.41E-27	2.44E-24	
380000	0.	0.	0.	0.	0.	0.	0.	0.	2.35E-33	4.09E-29	8.00E-26	3.43E-23	
412000	0.	0.	0.	0.	0.	0.	0.	0.	5.90E-36	2.30E-31	8.54E-28	6.10E-25	
408000	0.	0.	0.	0.	0.	0.	0.	0.	4.53E-36	1.60E-31	5.46E-28	3.66E-25	
439000	0.	0.	0.	0.	0.	0.	0.	0.	C.	1.07E-33	6.84E-30	7.52E-27	

Table 7. ENERGY LEVELS AND EQUILIBRIUM FRACTIONAL ELECTRONIC POPULATIONS OF O^+

STATE	LEVEL (CM-1)	LEVEL (EV)	STAT. WT.	200	250	300	TEMPERATURE (DEG K)					800	1000	1500
2s ² 2p ⁴ ⁴ P _{3/2}	0	0.0000	4	9.40E-01	9.12E-01	8.87E-01	8.48E-01	8.20E-01	7.98E-01	7.70E-01	7.51E-01	7.24E-01		
	285	0.0353	2	6.05E-02	8.84E-02	1.13E-01	1.52E-01	1.80E-01	2.02E-01	2.30E-01	2.49E-01	2.76E-01		
ENERGY LEVELS FROM HERRY ET AL. (43).														
LEVEL (CM-1)	2000	2500	3000	3500	4000	4500	5000	6000	7000	9000	10000			
C 285	7.11E-01	7.02E-01	6.96E-01	6.92E-01	6.89E-01	6.87E-01	6.85E-01	6.82E-01	6.80E-01	6.77E-01	6.76E-01			
	2.89E-01	2.99E-01	3.04E-01	3.08E-01	3.11E-01	3.13E-01	3.15E-01	3.18E-01	3.20E-01	3.22E-01	3.23E-01	3.24E-01		

Table 8. ENERGY LEVELS AND EQUILIBRIUM FRACTIONAL ELECTRONIC POPULATIONS OF O

STATE	LEVEL (CM-1)	STAT. WT.	200	250	300	400	500	600	800	1000	1500
2s 2p ³ ⁴ P ₁	0	5	9.12E-01	7.72E-01	7.42E-01	7.00E-01	6.74E-01	6.55E-01	6.31E-01	6.16E-01	5.97E-01
2p ³ ⁴ P ₁	158.4	3	1.56E-01	1.86E-01	2.08E-01	2.30E-01	2.50E-01	2.69E-01	2.85E-01	2.95E-01	3.07E-01
2p ³ ⁴ P ₂	226.5	1	3.10E-02	4.19E-02	5.01E-02	6.20E-02	7.02E-02	7.61E-02	8.40E-02	8.90E-02	9.60E-02
2p ³ ⁴ P ₂	15868	5	C.	0.	6.80E-34	1.14E-25	9.95E-21	1.95E-17	2.55E-13	7.49E-11	1.46E-07
2s 2p ³ ⁴ P ₁	33792	1	0.	0.	0.	C.	0.	8.42E-37	5.10E-28	9.46E-23	1.00E-15
2s 2p ³ ⁴ P ₂	126304	9	0.	0.	0.	C.	0.	C.	C.	C.	0.
2p ³ ⁴ P ₂	189837	3	0.	0.	0.	0.	0.	C.	C.	C.	C.
2p ³ ⁴ P ₂	277000*	1	C.	0.	0.	0.	0.	C.	C.	0.	0.
2s 2p ³ ⁴ P ₁	74903	8	0.	0.	0.	0.	0.	C.	C.	0.	0.
2s 2p ³ ⁴ P ₂	87379	24	0.	0.	0.	0.	0.	C.	C.	C.	1.14E-36
3d	97443	40	0.	0.	0.	0.	0.	C.	C.	0.	0.
4d	95757	8	0.	0.	0.	0.	0.	C.	C.	0.	0.
4p	99314	24	0.	0.	0.	0.	0.	C.	C.	0.	0.
4df	102900**	116	0.	0.	0.	0.	0.	C.	C.	0.	0.
(³ D*) 3s	101523	20	0.	0.	0.	0.	0.	C.	C.	0.	0.
3s	113600**	60	0.	0.	0.	0.	0.	C.	C.	0.	0.
3d	123940**	100	C.	0.	0.	0.	0.	C.	C.	0.	0.
4	128700**	320	0.	0.	0.	0.	0.	C.	C.	0.	0.
(³ P*) 3s	114416	12	0.	0.	0.	0.	0.	C.	C.	0.	0.
3p	127900**	36	C.	0.	0.	0.	0.	C.	C.	0.	0.
3d	138000*	60	0.	0.	0.	0.	0.	C.	C.	0.	0.
4	142100*	192	0.	0.	0.	0.	0.	C.	C.	0.	0.
2s 2p ³ (³ P)	212000*	216	0.	0.	0.	C.	0.	C.	C.	0.	0.
4	222000*	384	0.	0.	0.	0.	0.	C.	C.	0.	0.
(³ D) 3s	258000*	180	C.	0.	0.	0.	0.	C.	C.	0.	0.
4	268000*	320	0.	0.	0.	C.	0.	C.	C.	0.	0.
(³ S) 3s	287000*	36	0.	0.	0.	0.	0.	C.	C.	0.	0.
4	298000*	64	C.	0.	0.	C.	0.	C.	C.	0.	0.
(³ P) 3s	304000*	108	0.	0.	0.	0.	0.	C.	C.	0.	0.
4	314000*	192	0.	0.	0.	0.	0.	C.	C.	0.	0.
2p ³ (³ P*) 3s	409000*	108	0.	0.	0.	0.	0.	C.	C.	0.	0.
4	419000*	192	0.	0.	0.	0.	0.	C.	C.	0.	0.

*ESTIMATED.
 **INCLUDES ESTIMATED SUBLEVELS.
 ***STARRED ENERGY LEVELS FROM MOORE (3) AND ROSEN (44).
 NOTE: STATES INVOLVING ELECTRONS WITH PRINCIPAL QUANTUM NUMBERS ABOVE N = 4 ARE NOT INCLUDED.
 ALL LEVELS ABOVE 109837 CM-1 ARE SUBJECT TO AUTOCORRECTION.

Table 8 (Cont.). ENERGY LEVELS AND EQUILIBRIUM FRACTIONAL ELECTRONIC POPULATIONS OF O

LEVEL (CP-1)	TEMPERATURE (CEG K)										9CC0	ICCCC
	2CC0	25CC	3CC0	35CC	4000	45CC	5000	6CC0	7CC0	8CC0		
0	5.86E-01	5.80E-01	5.76E-01	5.73E-01	5.70E-01	5.67E-01	5.65E-01	5.59E-01	5.52E-01	5.45E-01	5.38E-01	5.31E-01
158	3.14E-01	3.18E-01	3.20E-01	3.22E-01	3.23E-01	3.24E-01	3.24E-01	3.23E-01	3.21E-01	3.18E-01	3.15E-01	3.11E-01
226	9.96E-02	1.02E-01	1.03E-01	1.04E-01	1.05E-01	1.06E-01	1.06E-01	1.05E-01	1.03E-01	1.05E-01	1.04E-01	1.03E-01
15868	6.46E-06	6.27E-05	2.85E-04	8.42E-04	1.89E-03	3.55E-03	5.87E-03	1.25E-02	2.12E-02	3.14E-02	4.26E-02	5.41E-02
33772	3.25E-12	4.15E-10	1.55E-08	1.06E-07	6.00E-07	2.30E-06	6.76E-06	3.38E-05	1.06E-04	2.50E-04	4.85E-04	8.21E-04
126304	0.	2.82E-32	5.11E-27	2.91E-23	1.91E-20	2.96E-18	1.67E-16	7.04E-14	5.28E-12	1.34E-10	1.65E-09	1.22E-08
189937	0.	0.	0.	4.41E-35	7.54E-31	1.48E-27	6.39E-25	5.89E-21	3.75E-18	4.87E-16	2.13E-14	4.38E-13
277000	0.	0.	0.	0.	0.	0.	2.73E-36	1.59E-30	2.07E-26	2.52E-23	6.31E-21	5.22E-19
74903	3.72E-24	1.76E-19	2.31E-16	3.89E-14	1.82E-12	3.61E-11	3.94E-10	1.42E-08	1.82E-07	1.23E-06	5.43E-06	1.77E-05
87379	1.41E-27	4.03E-22	1.75E-18	6.91E-16	6.13E-14	2.00E-12	3.26E-11	2.13E-09	4.20E-08	3.92E-07	2.22E-06	8.84E-06
97443	1.69E-30	2.05E-24	2.33E-20	1.84E-17	2.73E-15	1.34E-13	3.00E-12	3.18E-10	8.85E-09	1.07E-07	7.39E-07	3.46E-06
99757	1.14E-30	1.08E-24	1.05E-20	7.35E-18	1.00E-15	4.59E-14	9.75E-13	9.53E-11	2.50E-09	2.89E-08	1.54E-07	8.82E-07
59314	2.64E-31	4.19E-25	5.70E-21	5.11E-18	8.37E-16	4.41E-14	1.05E-12	1.22E-10	3.62E-09	4.58E-08	3.29E-07	1.59E-06
102900	9.65E-32	2.57E-25	4.93E-21	5.66E-18	1.11E-15	6.77E-14	1.81E-12	2.45E-10	6.36E-09	1.16E-07	8.96E-07	4.58E-06
101523	4.48E-32	9.79E-26	1.65E-21	1.72E-18	3.15E-16	1.81E-14	4.64E-13	5.98E-11	1.91E-09	2.57E-08	1.92E-07	9.62E-07
113600	2.27E-35	2.81E-28	1.51E-23	3.60E-20	1.23E-17	1.14E-15	4.31E-14	9.90E-12	4.80E-10	8.77E-09	8.38E-08	5.08E-07
123940	2.22E-38	1.22E-30	1.76E-25	8.55E-22	4.96E-19	7.00E-17	3.66E-15	1.38E-12	9.54E-11	2.28E-09	2.67E-08	1.91E-07
128700	0.	2.52E-31	5.76E-26	3.87E-22	2.87E-19	4.89E-17	2.98E-15	1.41E-12	1.15E-10	3.09E-09	4.00E-08	3.08E-07
114416	2.52E-36	3.52E-29	2.04E-24	5.15E-21	1.83E-18	1.76E-16	6.81E-15	1.63E-12	8.11E-11	1.51E-09	1.47E-08	9.03E-08
127900	0.	4.50E-32	9.51E-27	6.04E-23	4.30E-20	7.10E-18	4.22E-16	1.93E-13	1.52E-11	4.02E-10	5.11E-09	3.89E-08
138000	0.	2.24E-34	1.25E-28	1.58E-24	1.89E-21	4.68E-19	3.84E-17	2.85E-14	3.18E-12	1.09E-10	1.69E-09	1.52E-08
142100	0.	6.78E-35	5.59E-29	9.40E-25	1.39E-21	4.04E-19	3.78E-17	3.41E-14	4.35E-12	1.67E-10	2.82E-09	2.69E-08
212000	0.	0.	0.	3.51E-37	1.88E-32	8.94E-29	7.82E-26	2.02E-21	2.84E-18	6.51E-16	4.7E-14	1.30E-12
222000	0.	0.	0.	0.	9.15E-34	6.50E-30	7.82E-27	3.28E-22	6.47E-19	1.92E-16	1.60E-14	5.88E-13
258000	0.	0.	0.	0.	0.	3.05E-35	1.16E-31	2.72E-26	1.85E-22	1.38E-19	2.37E-17	1.45E-15
268000	0.	0.	0.	0.	0.	2.22E-36	1.16E-32	4.40E-27	4.22E-23	4.08E-20	8.52E-18	6.09E-16
287000	0.	0.	0.	0.	0.	0.	5.52E-36	5.19E-30	9.56E-26	1.50E-22	4.59E-20	4.46E-18
298000	0.	0.	0.	0.	0.	0.	4.14E-37	6.60E-31	1.77E-26	3.70E-23	1.41E-20	1.63E-18
304000	0.	0.	0.	0.	0.	0.	1.24E-37	2.64E-31	8.71E-27	2.12E-23	9.10E-21	1.16E-18
314000	0.	0.	0.	0.	0.	0.	0.	4.27E-32	1.98E-27	6.24E-24	3.27E-21	4.88E-19
405000	0.	0.	0.	0.	0.	0.	0.	0.	3.69E-36	1.33E-31	4.67E-28	3.18E-25
419000	0.	0.	0.	0.	0.	0.	0.	0.	8.40E-37	3.93E-32	1.68E-28	1.34E-25

Table 9. ENERGY LEVELS AND EQUILIBRIUM FRACTIONAL ELECTRONIC POPULATIONS OF O^+

STATE	LEVEL (CM-1)	LEVEL (eV)	STAT. WT.	20C	25C	30C	40C	50C	60C	80C	100C	150C
$2s^2 2p^3 \ ^3S^o$	0	0.0000	4	1.00E 00	1.00E 00	1.00E 00	1.00E 00	1.00E 00	1.00E 00	1.00E 00	1.00E 00	1.00E 00
$2s^2 2p^3 \ ^3D^o$	26819	3.3250	10	C.	0.	0.	0.	7.62E-34	2.94E-28	2.82E-21	4.36E-17	1.48E-11
$2s^2 2p^3 \ ^3P^o$	40467	5.0171	6	C.	0.	0.	0.	0.	C.	3.70E-32	7.72E-26	2.08E-17
$2s^2 2p^3 \ ^1D^o$	119931	14.8694	12	C.	0.	0.	0.	0.	C.	0.	0.	0.
$2s^2 2p^3 \ ^1S^o$	165941	20.5797	10	C.	0.	C.	C.	C.	C.	C.	C.	0.
$2s^2 2p^3 \ ^3S^o$	195710	24.2643	2	C.	C.	0.	0.	0.	C.	0.	0.	0.
$2s^2 2p^3 \ ^3P^o$	212650	26.3646	6	C.	0.	0.	0.	0.	0.	0.	0.	0.
$2s^2 2p^3 \ ^3P^o$	317400*	39.3516	6	C.	0.	0.	0.	0.	C.	C.	C.	0.
$2s^2 2p^3 \ ^3P^o$	186604	23.1354	18	C.	0.	C.	0.	0.	C.	C.	C.	0.
$2s^2 2p^3 \ ^3P^o$	209208	25.9378	54	0.	C.	C.	0.	0.	C.	0.	0.	0.
$3d$	232563	28.8334	90	C.	0.	0.	0.	0.	C.	C.	C.	C.
$4s$	239348	29.6746	18	C.	0.	0.	0.	0.	0.	C.	C.	C.
$4p$	246860**	30.6059	54	C.	0.	0.	0.	0.	C.	0.	0.	0.
$4d$	255006	31.6159	90	0.	0.	0.	0.	0.	0.	0.	0.	0.
$4f$	255932	31.7307	126	0.	0.	0.	C.	0.	C.	C.	C.	0.
$(^1D^o) 3s$	206772	25.6606	10	C.	0.	0.	0.	0.	C.	C.	C.	0.
$3p$	229898	28.5030	30	0.	0.	0.	0.	0.	C.	0.	0.	0.
$3d$	252571	31.3140	50	0.	0.	0.	0.	0.	C.	C.	C.	0.
$(^1S^o) 3s$	272930**	33.8381	160	C.	C.	0.	0.	0.	C.	0.	C.	0.
$(^1S^o) 3s$	226851*	28.1252	2	0.	C.	0.	0.	0.	C.	C.	C.	0.
$3p$	250251*	31.0264	6	0.	0.	0.	0.	0.	C.	C.	C.	0.
$3d$	275951*	34.2127	10	0.	C.	C.	C.	0.	C.	0.	C.	C.
4	296000*	36.6984	32	0.	0.	0.	0.	0.	C.	C.	C.	C.
$2s^2 2p^3 \ (^3S^o) 3$	281000*	34.8387	90	0.	C.	0.	0.	0.	C.	0.	C.	C.
$2s^2 2p^3 \ (^3S^o) 4$	313000**	38.8061	160	C.	0.	0.	C.	0.	C.	C.	C.	C.
$(^3D^o) 3$	340000*	42.1535	270	0.	C.	0.	C.	0.	C.	C.	C.	0.
$(^3P^o) 3-4$	373000*	46.2445	480	C.	0.	0.	0.	0.	C.	0.	0.	0.
$(^3S^o, ^1D^o, ^1P^o) 3-4$	383000*	47.4847	450	0.	0.	0.	C.	0.	C.	0.	C.	C.
$(^3S^o, ^1D^o, ^1P^o) 3-4$	437000*	54.1797	550	C.	0.	0.	0.	0.	C.	C.	C.	C.
$2p(^3P, ^1D, ^1S) 3-4$	534000*	66.2059	750	0.	0.	C.	0.	0.	C.	C.	C.	0.

* ESTIMATED.

** INCLUDES ESTIMATED SUBLEVELS.

*** STABLE ENERGY LEVELS FROM MCCRE (3) AND ERIKSSON (45).

NOTE: STATES INVOLVING ELECTRONS WITH PRINCIPAL QUANTUM NUMBERS ABOVE $n = 4$ ARE NOT INCLUDED.

ALL LEVELS ABOVE 283244 CM-1 ARE SUBJECT TO AUTOIONIZATION.

Table 9 (Cont.). ENERGY LEVELS AND EQUILIBRIUM FRACTIONAL ELECTRONIC POPULATIONS OF O⁺

LFVEL ICP-1)	2000	2500	3000	3500	TEMPERATURE (DEG K)					7000	8000	9000	10000
					4000	4500	5000	6000	7000				
1	1.00E-00	1.00E-00	1.00E-00	1.00E-00	1.00E-00	1.00E-00	9.55E-01	9.55E-01	9.55E-01	9.55E-01	9.79E-01	9.65E-01	9.46E-01
26815	1.04E-08	4.95E-07	6.45E-06	4.07E-05	1.02E-04	4.72E-04	1.11E-03	4.01E-03	5.59E-04	1.97E-02	3.31E-02	3.31E-02	4.99E-02
40667	1.41E-13	1.15E-10	5.59E-09	8.94E-08	7.15E-07	3.60E-06	1.31E-05	9.12E-05	3.62E-04	1.01E-03	2.24E-03	2.24E-03	4.20E-03
114934	1.02E-37	3.17E-30	1.14E-25	1.16E-21	5.52E-19	6.55E-17	3.08E-15	5.66E-13	5.84E-11	1.26E-09	1.36E-08	5.10E-08	5.10E-08
145991	C.	0.	6.67E-35	5.80E-30	2.94E-26	2.23E-23	4.50E-21	1.29E-17	3.77E-15	2.65E-13	7.21E-12	1.00E-10	1.00E-10
145710	C.	0.	0.	5.74E-36	1.34E-31	3.33E-28	1.74E-25	2.07E-21	1.68E-18	2.53E-16	1.25E-14	2.79E-13	2.79E-13
212650	C.	C.	C.	1.63E-38	5.06E-34	4.44E-30	3.98E-27	1.07E-22	1.55E-19	3.61E-17	2.49E-15	7.32E-14	7.32E-14
317400	C.	C.	C.	C.	0.	0.	C.	1.32E-33	6.50E-29	2.38E-25	1.33E-22	2.08E-20	2.08E-20
186604	C.	C.	C.	2.18E-33	3.18E-29	5.52E-26	2.15E-23	1.65E-19	9.80E-17	1.17E-14	4.81E-13	9.31E-12	9.31E-12
209208	C.	C.	C.	6.03E-37	2.81E-32	1.20E-28	5.66E-26	2.19E-21	2.82E-18	6.03E-16	3.89E-14	1.08E-12	1.08E-12
232563	C.	C.	C.	C.	1.05E-35	1.15E-31	1.94E-28	1.35E-23	3.87E-20	1.51E-17	1.55E-15	6.25E-14	6.25E-14
239348	C.	C.	C.	C.	1.83E-37	2.42E-33	5.51E-30	5.31E-25	1.52E-21	6.90E-19	1.05E-16	4.71E-15	4.71E-15
246860	C.	C.	C.	C.	3.65E-38	7.11E-34	1.90E-30	2.63E-25	1.23E-21	6.91E-19	9.45E-17	4.80E-15	4.80E-15
255006	C.	C.	C.	C.	C.	4.76E-35	3.04E-31	6.21E-26	3.84E-22	2.66E-19	4.28E-17	2.48E-15	2.48E-15
255932	C.	C.	C.	C.	C.	9.12E-35	3.26E-31	6.97E-26	4.45E-22	3.16E-19	5.17E-17	3.03E-15	3.03E-15
266972	C.	C.	C.	2.80E-37	1.16E-32	4.55E-29	3.40E-26	6.94E-22	8.28E-19	1.67E-16	1.03E-14	2.76E-13	2.76E-13
279898	C.	C.	C.	C.	9.15E-36	9.55E-32	1.39E-28	8.53E-24	2.23E-20	8.11E-18	7.90E-16	3.06E-14	3.06E-14
282571	C.	C.	C.	C.	C.	1.06E-34	3.41E-31	6.15E-26	3.52E-22	2.29E-19	3.51E-17	1.95E-15	1.95E-15
272930	C.	C.	C.	C.	C.	5.05E-37	3.11E-33	1.50E-27	1.72E-23	1.84E-20	4.34E-18	3.34E-16	3.34E-16
276851	C.	C.	C.	C.	1.83E-36	1.58E-32	2.23E-29	1.18E-24	2.78E-21	9.36E-19	8.58E-17	3.16E-15	3.16E-15
250251	C.	C.	C.	C.	C.	2.67E-35	7.97E-32	1.30E-26	6.80E-23	4.17E-20	6.11E-18	3.27E-16	3.27E-16
275951	C.	C.	C.	C.	C.	1.20E-38	8.15E-35	4.55E-29	5.76E-25	6.84E-22	1.67E-19	1.35E-17	1.35E-17
256000	C.	C.	C.	C.	C.	0.	8.15E-37	1.17E-30	2.59E-26	5.95E-23	2.17E-20	2.42E-18	2.42E-18
271000	C.	C.	C.	C.	C.	C.	1.72E-34	1.22E-29	1.84E-24	2.48E-21	6.72E-19	5.89E-17	5.89E-17
313000	C.	C.	C.	C.	C.	C.	C.	1.01E-31	4.54E-27	1.40E-23	7.17E-21	1.05E-18	1.05E-18
340000	C.	C.	C.	C.	C.	C.	C.	2.62E-34	2.98E-29	1.84E-25	1.61E-22	3.63E-20	3.63E-20
371000	C.	C.	C.	C.	C.	C.	C.	C.	6.01E-32	8.43E-28	1.47E-24	5.60E-22	5.60E-22
383000	C.	C.	C.	C.	C.	C.	C.	C.	7.21E-33	1.34E-28	2.78E-25	1.24E-22	1.24E-22
437000	C.	C.	C.	C.	C.	C.	C.	C.	C.	9.92E-33	6.06E-29	6.42E-26	6.42E-26
540000	C.	C.	C.	C.	C.	C.	C.	C.	C.	C.	1.52E-35	7.61E-32	7.61E-32

Table 10. ENERGY LEVELS AND EQUILIBRIUM FRACTIONAL ELECTRONIC POPULATIONS OF Ar

STATE	LEVEL (eV)	STAT. WT.	200	250	300	T _e	ATMURE (DEG K)	500	600	800	1000	1500
3s ² 3p ⁶ 1S												
3s ² 3p ⁵ (P _{1/2}) 3d	C	1	1.00E 00	1.00E 00	1.00E 00	1.00E 00	1.00E 00	1.00E 00	1.00E 00	1.00E 00	1.00E 00	1.00E 00
	114854	2C	C.	C.	C.	C.	C.	C.	C.	C.	C.	C.
4s	95108	4	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4p	107421	12	C.	C.	C.	C.	C.	C.	C.	C.	C.	C.
4d	120721	2C	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	14.9671											
4f	121654	28	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
3s ² 3p ⁵ (P _{3/2}) 3d												
	112948	4C	C.	0.	0.	C.	0.	0.	0.	0.	0.	0.
4s	93371	8	C.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4p	105631	24	C.	C.	C.	C.	C.	C.	C.	C.	C.	C.
4d	115211	4C	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	14.7799											
4f	120222	56	C.	C.	C.	0.	0.	0.	0.	0.	0.	0.
3s ² 3p ⁵ (S) 3d												
	222000*	2C	C.	C.	0.	0.	0.	0.	0.	0.	0.	0.
4s	203000*	4	C.	0.	0.	0.	0.	0.	0.	0.	0.	0.
4p	215000*	12	C.	0.	0.	C.	C.	C.	C.	C.	C.	C.
4d	227500*	2C	0.	C.	C.	0.	0.	0.	0.	0.	0.	0.
	28.2553											
4f	228900*	28	C.	0.	0.	0.	0.	0.	0.	0.	0.	0.
	28.3793											

*ESTIMATED.

ENERGY LEVELS FROM CORE (3) BURNS AND ADAMS (46) AND HUMPHREYS AND PAUL (47).

NOTE: STATES INVOLVING ELECTRONS WITH PRINCIPAL QUANTUM NUMBERS ABOVE N = 4 ARE NOT INCLUDED.

ALL LEVELS ABOVE 127110 CM-1 ARE SUBJECT TO AUTOCIONIZATION.

Table 10 (Cont.). ENERGY LEVELS AND EQUILIBRIUM FRACTIONAL ELECTRONIC POPULATIONS OF Ar

LEVEL (CM ⁻¹)	2000	2500	3000	3500	4000	4500	5000	6000	7000	8000	9000	10000
C	1.00E-00	1.00E-00	1.00E-00	1.00E-00	1.00E-00	1.00E-00	1.00E-00	1.00E-00	1.00E-00	1.00E-00	1.00E-00	1.00E-00
114054	2.61E-35	1.93E-24	2.39E-23	6.25E-20	2.75E-17	2.29E-15	8.86E-14	2.14E-11	1.12E-09	2.14E-08	1.00E-07	1.00E-00
95188	7.29E-30	6.46E-24	5.97E-20	4.06E-17	5.40E-15	2.42E-13	5.08E-12	4.85E-10	1.27E-08	1.47E-07	2.12E-07	1.33E-06
107421	3.29E-33	1.70E-26	5.07E-22	7.97E-19	1.99E-16	1.46E-14	4.51E-13	7.80E-11	3.05E-09	4.88E-08	5.81E-07	4.51E-06
120721	3.44E-37	1.34E-29	1.43E-24	5.61E-21	2.77E-18	3.43E-16	1.64E-14	5.36E-12	3.35E-10	7.44E-09	8.31E-08	2.33E-06
121654	2.75E-37	1.10E-29	1.28E-24	5.35E-21	2.77E-18	3.59E-16	1.75E-14	5.99E-12	3.87E-10	6.31E-09	1.00E-07	5.72E-07
112948	2.06E-34	2.35E-27	1.19E-22	2.74E-19	9.08E-17	8.29E-15	3.07E-13	6.91E-11	3.31E-09	6.03E-08	5.76E-07	7.01E-07
93371	5.30E-29	3.68E-23	2.85E-19	1.71E-16	7.08E-14	8.67E-13	1.72E-11	1.51E-09	3.70E-08	4.08E-07	2.63E-06	3.50E-06
10561	2.39E-32	9.52E-26	2.39E-21	3.33E-18	7.57E-16	5.16E-14	1.51E-12	2.40E-10	2.53E-09	1.35E-07	1.11E-06	1.17E-05
119211	2.28E-36	6.40E-29	5.92E-24	2.09E-20	9.54E-18	1.12E-15	5.06E-14	1.54E-11	5.13E-10	1.35E-08	2.12E-07	6.02E-06
120222	1.54E-36	5.01E-29	5.10E-24	1.93E-20	9.28E-18	1.13E-15	5.29E-14	1.69E-11	1.04E-09	2.28E-08	2.52E-07	1.74E-06
222000	C.	0.	C.	C.	4.18E-34	2.90E-30	3.61E-27	1.52E-22	3.05E-19	3.15E-17	7.72E-15	2.63E-13
203000	0.	0.	C.	2.29E-36	7.77E-32	2.59E-28	1.71E-25	2.85E-21	3.03E-18	5.58E-16	3.22E-14	8.27E-13
215000	0.	0.	C.	4.95E-38	3.11E-33	1.68E-29	1.62E-26	4.88E-22	7.71E-19	1.43E-16	1.42E-14	4.41E-13
227900	0.	C.	C.	C.	5.01E-35	4.52E-31	6.61E-28	3.69E-23	5.07E-20	1.16E-17	3.01E-15	1.15E-13
228900	C.	0.	C.	C.	4.85E-35	4.60E-31	6.94E-28	4.06E-23	1.03E-19	1.70E-17	3.59E-15	1.34E-13

Table 11. ENERGY LEVELS AND EQUILIBRIUM FRACTIONAL POPULATIONS OF Ar⁺

STATE	LEVEL (CM-1)	LEVEL (EV)	STAT. WT.	TEMPERATURE (DEG K)								
				200	250	300	400	500	600	800	1000	1500
3s ² 3p ⁴ 2P _{1/2} 3s ² 3p ⁴ 2P _{3/2} 3s ² 3p ⁴ 2S 3s ² 3p ⁴ (P) 3d ¹ D 3d other	C	0.0000	4	1.00E-00	1.00E-00	9.59E-01	9.97E-01	9.92E-01	9.84E-01	9.63E-01	9.70E-01	8.88E-01
	1432.0	0.1775	2	1.68E-05	1.32E-04	5.20E-04	2.85E-03	8.05E-03	1.59E-02	3.67E-02	5.99E-02	1.12E-01
	108723	13.4796	2	0.	0.	0.	0.	0.	0.	0.	0.	0.
	132476	16.4245	20	0.	0.	0.	0.	0.	0.	0.	0.	0.
	146319	18.1408	70	0.	0.	0.	0.	0.	0.	0.	0.	0.
4s 4p 4d 4f (D)3d	136028	16.8649	18	0.	0.	0.	0.	0.	0.	0.	0.	0.
	158023	19.5918	54	0.	0.	0.	0.	0.	0.	0.	0.	0.
	186693	23.1464	90	0.	0.	0.	0.	0.	0.	0.	0.	0.
	195567	24.2466	126	0.	0.	0.	0.	0.	0.	0.	0.	0.
	164082	20.3431	50	0.	0.	0.	0.	0.	0.	0.	0.	0.
4s 4p 4d 4f (S)3d	148754	18.4427	10	0.	0.	0.	0.	0.	0.	0.	0.	0.
	171831	21.3038	30	0.	0.	0.	0.	0.	0.	0.	0.	0.
	199657	24.7537	50	0.	0.	0.	0.	0.	0.	0.	0.	0.
	209029	15.9156	10	0.	0.	0.	0.	0.	0.	0.	0.	0.
	179728	22.2829	10	0.	0.	0.	0.	0.	0.	0.	0.	0.
4s 4p 4d 4f 3s 3p (P) 3d	167309	20.7431	2	0.	0.	0.	0.	0.	0.	0.	0.	0.
	192095	23.8161	6	0.	0.	0.	0.	0.	0.	0.	0.	0.
	220000*	27.2758	10	0.	0.	0.	0.	0.	0.	0.	0.	0.
	228000*	28.2677	14	0.	0.	0.	0.	0.	0.	0.	0.	0.
	269000*	33.3509	90	0.	0.	0.	0.	0.	0.	0.	0.	0.
4s 4p 4d 4f	245000*	30.8713	18	0.	0.	0.	0.	0.	0.	0.	0.	0.
	273000*	33.8468	54	0.	0.	0.	0.	0.	0.	0.	0.	0.
	301000*	37.3183	90	0.	0.	0.	0.	0.	0.	0.	0.	0.
	309000*	38.3101	126	0.	0.	0.	0.	0.	0.	0.	0.	0.

*ESTIMATED.
ENERGY LEVELS FROM MOORE (3) AND MINNIPACEN (48).
NOTE: STATES INVOLVING ELECTRONS WITH PRINCIPAL QUANTUM NUMBERS ABOVE N = 4 ARE NOT INCLUDED.
ALL LEVELS ABOVE 222848 CM-1 ARE SUBJECT TO AUTOCIONIZATION.

Table 12. ENERGY LEVELS AND EQUILIBRIUM FRACTIONAL ELECTRONIC POPULATIONS OF CO

TEMP. (DEG K)	STATE						
	X $1\Sigma^+$	a 3Π	a' $3\Sigma^+$	d 3Δ	e $3\Sigma^-$	I $1\Sigma^-$	A 1Π
ENERGY (CM-1)	0	49474	55354	60647	63709	64547	64747
(EV)	0.0000	6.0099	6.8628	7.5191	7.8987	8.0026	8.0273
VIB. (CM-1)	2143	1715	1209	1138	1094	1071	1481
INT. (EV)	0.2657	0.2126	0.1499	0.1410	0.1357	0.1328	0.1836
FRACTIONAL POPULATION							
200	1.00E 00	0.	0.	0.	0.	0.	0.
250	1.00E 00	0.	0.	0.	0.	0.	0.
300	1.00E 00	0.	0.	0.	0.	0.	0.
400	1.00E 00	0.	0.	0.	0.	0.	0.
500	1.00E 00	0.	0.	0.	0.	0.	0.
600	1.00E 00	0.	0.	0.	0.	0.	0.
800	1.00E 00	0.	0.	0.	0.	0.	0.
1000	1.00E 00	3.68E-30	1.30E-34	0.	0.	0.	0.
1500	1.00E 00	4.77E-20	4.85E-23	6.43E-25	1.78E-26	2.73E-27	2.98E-27
2000	1.00E 00	5.49E-15	3.03E-17	1.44E-18	8.34E-20	1.57E-20	1.73E-20
2500	1.00E 00	5.99E-12	9.17E-14	9.35E-15	8.48E-16	1.80E-16	1.99E-16
3000	1.00E 00	6.37E-10	1.33E-11	3.28E-12	4.01E-13	9.20E-14	1.02E-13
3500	1.00E 00	1.79E-08	8.85E-10	2.17E-10	3.28E-11	7.94E-12	8.83E-12
4000	1.00E 00	2.19E-07	1.56E-08	5.04E-09	8.96E-10	2.25E-10	2.51E-10
4500	1.00E 00	1.53E-06	1.46E-07	5.84E-08	1.18E-08	3.03E-09	3.40E-09
5000	1.00E 00	7.29E-06	8.77E-07	4.15E-07	9.26E-08	2.42E-08	2.73E-08
6000	1.00E 00	7.58E-05	1.29E-05	7.91E-06	2.04E-06	5.45E-07	6.21E-07
7000	9.99E-01	4.05E-04	8.87E-05	6.48E-05	1.86E-05	4.97E-06	5.73E-06
8000	9.98E-01	1.42E-03	3.74E-04	3.12E-04	9.60E-05	2.57E-05	2.99E-05
9000	9.94E-01	3.77E-03	1.14E-03	1.55E-03	3.40E-04	9.08E-05	1.07E-04
10000	9.85E-01	8.15E-03	2.75E-03	2.71E-03	9.17E-04	2.45E-04	2.89E-04

Based on energy-level data from references 49 and 57.

Table 13. ENERGY LEVELS AND EQUILIBRIUM FRACTIONAL ELECTRONIC POPULATIONS OF N₂

STATE										
	X $1\Sigma_g^+$	A $3\Sigma_u^+$	$3\Delta_u$	B $3\Pi_g$	B' $3\Sigma_u^-$	a' $1\Sigma_u^-$	a $1\Pi_g$	w $1\Delta_u$		
ENERGY (CM-1)	0	49756	~58000	59310	65852	67739	68951	71698		
(EV)	0.0000	6.1688	~7.1909	7.3533	8.1644	8.3984	8.5486	8.8802		
VIB. (CM-1)	2330	1433	~1464	1705	1493	1506	1666	1535		
INT. (EV)	0.2888	0.1777	~0.1815	0.2114	0.1851	0.1867	0.2066	0.1904		
TEMP.										
(DEG K)	FRACTIONAL POPULATION									
200	1.00E 00	0.	0.	0.	0.	0.	0.	0.		
250	1.00E 00	0.	0.	0.	0.	0.	0.	0.		
300	1.00E 00	0.	0.	0.	0.	0.	0.	0.		
400	1.00E 00	0.	0.	0.	0.	0.	0.	0.		
500	1.00E 00	0.	0.	0.	0.	0.	0.	0.		
600	1.00E 00	0.	0.	0.	0.	0.	0.	0.		
800	1.00E 00	0.	0.	0.	0.	0.	0.	0.		
1000	1.00E 00	3.72E-31	0.	0.	0.	0.	0.	0.		
1500	1.00E 00	9.34E-21	6.77E-24	1.60E-24	1.78E-27	9.62E-29	5.27E-29	4.22E-30		
2000	1.00E 00	1.51E-15	7.87E-18	2.51E-18	1.36E-20	1.15E-21	8.33E-22	1.30E-22		
2500	1.00E 00	2.03E-12	3.46E-14	1.31E-14	1.84E-16	2.05E-17	1.75E-17	4.09E-18		
3000	1.00E 00	2.49E-10	9.33E-12	3.97E-12	1.05E-13	1.40E-14	1.34E-14	4.09E-15		
3500	1.00E 00	7.75E-09	5.10E-10	2.35E-10	9.83E-12	1.49E-12	1.54E-12	5.09E-13		
4000	1.00E 00	1.02E-07	1.03E-08	5.04E-09	2.96E-10	4.94E-11	5.40E-11	2.31E-11		
4500	1.00E 00	7.64E-07	1.06E-07	5.47E-08	4.19E-09	7.54E-10	8.62E-10	4.13E-10		
5000	1.00E 00	3.82E-06	6.91E-07	3.69E-07	3.50E-08	6.68E-09	7.92E-09	4.15E-09		
6000	1.00E 00	4.28E-05	1.15E-05	4.47E-06	8.48E-07	1.77E-07	2.21E-07	1.33E-07		
7000	1.00E 00	2.40E-04	8.56E-05	5.02E-05	8.29E-06	1.84E-06	2.39E-06	1.59E-06		
8000	9.98E-01	8.67E-04	3.86E-04	2.33E-04	4.59E-05	1.07E-05	1.43E-05	1.02E-05		
9000	9.95E-01	2.33E-03	1.24E-03	7.64E-04	1.74E-04	4.19E-05	5.76E-05	4.34E-05		
10000	9.89E-01	5.08E-03	3.13E-03	1.96E-03	5.00E-04	1.25E-04	1.75E-04	1.38E-04		

Tables 13 to 18 are based on energy-level data from reference 50.

Table 14. ENERGY LEVELS AND EQUILIBRIUM FRACTIONAL ELECTRONIC POPULATIONS OF N_2^+

TEMP. (DEG K)	STATE										C
	X $2\Sigma_g^+$	A $2\Pi_u$	B $2\Sigma_u^+$	$4\Sigma_u^+$	$4\Delta_u$	D $2\Pi_g$	$4\Sigma_u^-$	$2\Sigma_u^+$			
ENERGY (CM-1)	0	9016	25566	~44328	~51328	51203	~60328	64542			
(EV)	0.0000	1.1178	3.1697	~5.4958	~6.3637	6.3482	~7.4795	8.0020			
VIB. (CM-1)	2175	1873	2371	~1668	~1572	889	~1472	2051			
INT. (EV)	0.2696	0.2323	0.2940	~0.2068	~0.1949	0.1102	~0.1825	0.2543			
FRACTIONAL POPULATION											
200	1.00E 00	1.50E-28	0.	0.	0.	0.	0.	0.			
250	1.00E 00	6.44E-23	0.	0.	0.	0.	0.	0.			
300	1.00E 00	3.67E-19	0.	0.	0.	0.	0.	0.			
400	1.00E 00	1.82E-14	0.	0.	0.	0.	0.	0.			
500	1.00E 00	1.19E-11	1.04E-32	0.	0.	0.	0.	0.			
600	1.00E 00	9.05E-10	2.19E-27	0.	0.	0.	0.	0.			
800	1.00E 00	2.03E-07	9.87E-21	5.92E-35	0.	0.	0.	0.			
1000	1.00E 00	5.26E-06	9.68E-17	5.08E-28	4.37E-32	4.75E-32	0.	0.			
1500	1.00E 00	4.07E-04	2.02E-11	9.09E-19	2.26E-21	2.58E-21	2.37E-25	1.67E-27			
2000	9.96E-01	3.59E-03	9.16E-09	3.88E-14	5.21E-16	6.18E-16	4.76E-19	8.84E-21			
2500	9.87E-01	1.32E-02	3.57E-07	2.32E-11	8.57E-13	1.05E-12	2.87E-15	9.49E-17			
3000	9.69E-01	3.11E-02	4.05E-06	1.63E-09	1.18E-10	1.50E-10	9.45E-13	4.56E-14			
3500	9.43E-01	5.67E-02	2.26E-05	3.34E-08	3.96E-09	5.16E-09	5.87E-11	3.70E-12			
4000	9.12E-01	8.79E-02	8.13E-05	3.18E-07	5.43E-08	7.24E-08	1.28E-09	9.88E-11			
4500	8.78E-01	1.22E-01	2.17E-04	1.81E-06	4.11E-07	5.58E-07	1.40E-08	1.25E-09			
5000	8.42E-01	1.57E-01	4.73E-04	7.17E-06	2.06E-06	2.82E-06	9.34E-08	9.46E-09			
6000	7.74E-01	2.25E-01	1.49E-03	5.49E-05	2.25E-05	3.10E-05	1.58E-06	1.90E-07			
7000	7.12E-01	2.84E-01	3.32E-03	2.27E-04	1.21E-04	1.65E-04	1.15E-05	1.57E-06			
8000	6.59E-01	3.33E-01	6.01E-03	6.37E-04	4.20E-04	5.56E-04	4.99E-05	7.40E-06			
9000	6.13E-01	3.74E-01	9.46E-03	1.39E-03	1.09E-03	1.33E-03	1.53E-04	2.41E-05			
10000	5.73E-01	4.06E-01	1.35E-02	2.52E-03	2.28E-03	2.80E-03	3.65E-04	6.05E-05			

Table 15. ENERGY LEVELS AND EQUILIBRIUM FRACTIONAL ELECTRONIC POPULATIONS OF NO

ENERGY (CM-1) (EV)	χ $^2\Pi$	STATE					$^2\Sigma^+$
		a $^4\Pi$	A $^2\Sigma^+$	B $^2\Pi$	b $^4\Sigma^-$	C $^2\Pi$	
62*							
0.0077*		~37965	44159	45505	~47092	52380**	53291
		~4.7069	5.4799	5.6418	~5.8385	6.4941**	6.6071
1876		995	2342	1023	~1203	2365**	2279
0.2326		0.1234	0.2903	0.1268	~0.1491	0.2932**	0.2826
TEMP. (DEG K)							
		FRACTIONAL POPULATION					
200	1.00E 00	0.	0.	0.	0.	0.	0.
250	1.00E 00	0.	0.	0.	0.	0.	0.
300	1.00E 00	0.	0.	0.	0.	0.	0.
400	1.00E 00	0.	0.	0.	0.	0.	0.
500	1.00E 00	0.	0.	0.	0.	0.	0.
600	1.00E 00	0.	0.	0.	0.	0.	0.
800	1.00E 00	8.47E-30	1.4CE-35	0.	0.	0.	0.
1000	1.00E 00	7.49E-24	1.08E-28	7.45E-29	5.89E-30	1.67E-33	2.26E-34
1500	1.00E 00	6.58E-16	1.63E-19	2.41E-19	3.99E-20	1.27E-22	2.68E-23
2000	1.00E 00	6.31E-12	6.26E-15	1.40E-14	3.34E-15	3.48E-17	9.07E-18
2500	1.00E 00	1.56E-09	3.49E-12	1.01E-11	3.04E-12	6.30E-14	1.85E-14
3000	1.00E 00	6.20E-08	2.34E-10	8.24E-10	2.87E-10	9.31E-12	2.93E-12
3500	1.00E 00	8.61E-07	4.65E-09	1.91E-08	7.43E-09	3.26E-10	1.06E-10
4000	1.00E 00	6.17E-06	4.32E-08	2.02E-07	8.56E-08	4.65E-09	1.54E-09
4500	1.00E 00	2.83E-05	2.41E-07	1.27E-06	5.74E-07	3.63E-08	1.21E-08
5000	1.00E 00	9.52E-05	9.40E-07	5.51E-06	2.63E-06	1.86E-07	6.20E-08
6000	9.99E-01	5.73E-04	7.00E-06	4.98E-05	2.57E-05	2.09E-06	6.89E-07
7000	9.98E-01	2.00E-03	2.82E-05	2.37E-04	1.29E-04	1.13E-05	3.68E-06
8000	9.94E-01	4.94E-03	7.75E-05	7.56E-04	4.22E-04	3.88E-05	1.24E-05
9000	9.87E-01	9.73E-03	1.65E-04	1.83E-03	1.04E-03	9.85E-05	3.11E-05
10000	9.77E-01	1.63E-02	2.94E-04	3.65E-03	2.11E-03	2.02E-04	6.29E-05

* Average energy of the two spin components, above that of the lower component ($^2\Pi_1$).

** "Deperturbed" values.

FRACTICNAL POPULATION

ENERGY (CM-1) (EV)	X $1\Sigma^+$	a $3\Sigma^+$	STATE			$A^1\Pi$	$3\Sigma^-$
			3Δ	3Π			
	0	~39934	~58804	~63764	73084	~73334	
	0.0000	~4.9511	~7.2906	~7.9055	9.0610	~9.0920	
VIR. (CM-1)	2344	~1572	~1972	~1672	1562	~1176	
INT. (EV)	0.2907	~0.7349	~0.2445	~0.2073	0.1937	~0.1458	
TEMP. (DEG K)			FRACTICNAL POPULATION				
200	1.00E 00	0.	0.	0.	0.	0.	
250	1.00E 00	0.	0.	0.	0.	0.	
300	1.00E 00	0.	0.	0.	0.	0.	
400	1.00E 00	0.	0.	0.	0.	0.	
500	1.00E 00	0.	0.	0.	0.	0.	
600	1.00E 00	0.	0.	0.	0.	0.	
800	1.00E 00	2.46E-31	0.	0.	0.	0.	
1000	1.00E 00	4.39E-25	0.	0.	0.	0.	
1500	1.00E 00	9.76E-17	2.70E-24	2.01E-26	1.06E-30	1.87E-30	
2000	1.00E 00	1.48E-12	3.67E-18	9.19E-20	4.55E-23	8.79E-23	
2500	1.00E 00	4.80E-10	1.76E-14	9.15E-16	1.75E-18	3.54E-18	
3000	1.00E 00	2.28E-08	5.04E-12	4.25E-13	2.01E-15	4.13E-15	
3500	1.00E 00	3.60E-07	2.86E-10	3.43E-11	3.10E-13	6.33E-13	
4000	1.00E 00	2.86E-06	5.94E-09	9.27E-10	1.36E-11	2.72E-11	
4500	1.00E 00	1.43E-05	6.31E-08	1.21E-08	2.59E-10	4.99E-10	
5000	1.00E 00	5.22E-05	4.19E-07	9.45E-08	2.73E-09	5.04E-09	
6000	1.00E 00	3.63E-04	7.22E-06	2.08E-06	9.30E-08	1.57E-07	
7000	9.98E-01	1.45E-03	5.57E-05	1.90E-05	1.14E-06	1.75E-06	
8000	9.96E-01	4.10E-03	2.58E-04	9.93E-05	7.39E-06	1.04E-05	
9000	9.90E-01	9.14E-03	8.48E-04	3.56E-04	3.09E-05	4.00E-05	
10000	9.79E-01	1.72E-02	2.18E-03	9.78E-04	9.52E-05	1.15E-04	

Table 17. ENERGY LEVELS AND EQUILIBRIUM FRACTIONAL ELECTRONIC POPULATIONS OF O₂

ENERGY (CM-1) (EV)	X $3\Sigma^-_g$	STATE						B $3\Sigma^-_u$
		a $1\Delta_g$	b $1\Sigma^+_g$	C $3\Delta_u$	A $3\Sigma^+_u$	c $1\Sigma^-_u$		
VIB. (CM-1)	1556	1483	1405	~820	775	616	688	
INT. (EV)	0.1930	0.1839	0.1742	~0.1017	0.0960	0.0764	0.0853	
TEMP. (DEC K)		FRACTIONAL POPULATION						
200	1.00E 00	1.60E-25	0.	0.	0.	0.	0.	
250	1.00E 00	1.34E-20	5.53E-34	0.	0.	0.	0.	
300	1.00E 00	2.58E-17	1.62E-28	0.	0.	0.	0.	
400	1.00E 00	3.29E-13	1.10E-21	0.	0.	0.	0.	
500	1.00E 00	9.56E-11	1.39E-17	0.	0.	0.	0.	
600	1.00E 00	4.20E-09	7.54E-15	0.	0.	0.	0.	
800	1.00E 00	4.76E-07	1.99E-11	5.78E-27	9.21E-28	4.47E-29	0.	
1000	1.00E 00	8.14E-06	2.25E-09	1.43E-21	2.90E-22	2.24E-23	3.73E-31	
1500	1.00E 00	3.60E-04	1.24E-06	2.30E-14	6.30E-15	9.18E-16	8.26E-21	
2000	9.98E-01	2.39E-03	2.91E-05	9.29E-11	2.89E-11	5.68E-12	1.25E-15	
2500	9.92E-01	7.44E-03	1.94E-04	1.32E-08	4.37E-09	1.01E-09	1.57E-12	
3000	9.84E-01	1.58E-02	6.82E-04	3.47E-07	1.19E-07	3.05E-08	1.78E-10	
3500	9.72E-01	2.68E-02	1.67E-03	3.46E-06	1.21E-06	3.32E-07	5.08E-09	
4000	9.57E-01	3.98E-02	3.25E-03	1.88E-05	6.68E-06	1.92E-06	6.08E-08	
4500	9.41E-01	5.37E-02	5.43E-03	6.82E-05	2.45E-05	7.26E-06	4.08E-07	
5000	9.23E-01	6.81E-02	8.16E-03	1.86E-04	6.73E-05	2.05E-05	1.83E-06	
6000	8.88E-01	9.60E-02	1.48E-02	7.96E-04	2.90E-04	9.17E-05	1.64E-05	
7000	8.53E-01	1.21E-01	2.24E-02	2.11E-03	7.75E-04	2.51E-04	7.39E-05	
8000	8.21E-01	1.43E-01	3.00E-02	4.20E-03	1.55E-03	5.10E-04	2.19E-04	
9000	7.91E-01	1.61E-01	3.72E-02	6.94E-03	2.56E-03	8.56E-04	4.93E-04	
10000	7.65E-01	1.75E-01	4.36E-02	1.01E-02	3.74E-03	1.26E-03	9.21E-04	

Table 18. ENERGY LEVELS AND EQUILIBRIUM FRACTIONAL ELECTRONIC POPULATIONS OF O_2^+

TEMP. (DEG K)	STATE			
	$X \ 2\Pi_g$	$a \ 4\Pi_u$	$A \ 2\Pi_u$	$b \ 4\Sigma_g^-$
ENERGY (CM-1)	98*	32571	38303	49238
(EV)	0.0122*	4.0382	4.7488	6.1046
VIB. (CM-1)	1843	1015	872	1163
INT. (EV)	0.2286	0.1258	0.1081	0.1441
FRACTIONAL POPULATION				
200	1.00E 00	0.	0.	0.
250	1.00E 00	0.	0.	0.
300	1.00E 00	0.	0.	0.
400	1.00E 00	0.	0.	0.
500	1.00E 00	0.	0.	0.
600	1.00E 00	5.00E-34	0.	0.
800	1.00E 00	1.52E-25	2.81E-30	0.
1000	1.00E 00	1.89E-20	2.81E-24	2.96E-31
1500	1.00E 00	1.22E-13	2.92E-16	5.54E-21
2000	1.00E 00	3.16E-10	3.06E-12	7.71E-16
2500	1.00E 00	3.56E-08	8.02E-10	9.51E-13
3000	1.00E 00	8.38E-07	3.31E-08	1.10E-10
3500	1.00E 00	8.03E-06	4.72E-07	3.31E-09
4000	1.00E 00	4.39E-05	3.46E-06	4.25E-08
4500	1.00E 00	1.65E-04	1.67E-05	3.10E-07
5000	9.99E-01	4.74E-04	5.54E-05	1.52E-06
6000	9.97E-01	2.29E-03	3.41E-04	1.63E-05
7000	9.92E-01	6.92E-03	1.21E-03	8.73E-05
8000	9.81E-01	1.55E-02	3.01E-03	2.99E-04
9000	9.65E-01	2.82E-02	5.94E-03	7.58E-04
10000	9.44E-01	4.44E-02	9.93E-03	1.56E-03

* Average energy of the two spin components, above that of the lower component ($^2\Pi_{1/2}$).

Table 19. LOWER ELECTRONIC AND VIBRATIONAL ENERGY LEVELS OF SELECTED DIATOMIC MOLECULES. UNITS: cm^{-1} and ev

Molecule	State	Electronic Energy	Lowest Vibrational Interval	References
H_2	$\text{X}^1\Sigma_g^+$	0 cm^{-1} 0 ev	4161 0.516	51
H_2^+	$\text{X}^2\Sigma_g^+$	0 0	2191 0.272	14
CO^+	$\text{X}^2\Sigma^+$	0 0	2184 0.271	52
	$\text{A}^2\Pi$	20408 2.530	1535 0.190	
	$\text{B}^2\Sigma^+$	45633 5.658	1679 0.208	
NO^-	$\text{X}^3\Sigma^-$	0 0	(~1600) (~0.20)	*
O_2^-	$\text{X}^2\Pi_g$	0 0	(~143) (0.143)	53
OH^-	$\text{X}^1\Sigma^+$	0 0	(3600) (0.446)	28
OH	$\text{X}^2\Sigma$	0 0	3570 0.443	52
	$\text{A}^2\Sigma^+$	32402 4.017	2989 0.371	
OH^+	$\text{X}^3\Sigma^-$	0 0	2967 0.368	52
	$\text{A}^3\Pi$	27952 3.466	1986 0.246	
*Vibrational interval estimated from O_2 .				

Table 20. VIBRATIONAL SPACING OF TRIATOMIC MOLECULES

Molecule	Ground State	Vibrational Intervals (cm^{-1} ; eV)			References
		ν_1	ν_2	ν_3	
H_2O	$^1\text{A}_1$	3657 0.453	1595 0.198	3756 0.466	32
H_2O^+	$(^2\text{B}_1)$	(~3200) (~0.40)	(~1500) (~0.19)	(~3300) (~0.41)	*
CO_2	$^1\Sigma_g^+$	1388 0.172	667 0.083	2349 0.291	32
CO_2^+	$^2\Pi_g$	1280 0.159	(~400) (~0.05)	(1469) (0.182)	32
NO_2^-	$^1\text{A}_1$	(1325) (0.164)	(829) (0.103)	(1270) (0.157)	54
NO_2	$^2\text{A}_1$	(1320) (0.164)	750 0.093	1618 0.201	32
NO_2^+	$(^1\Sigma_g^+)$	(1400) (0.174)	(538) (0.067)	(2360) (0.293)	55
N_2O	$^1\Sigma^+$	2224 0.276	589 0.073	1285 0.159	32
N_2O^+	$^2\Pi$	1737 0.215	461 0.057	1126 0.140	32
O_3^-	$(^2\text{B}_1)$	(1260) (0.156)	(800) (0.099)	(1140) (0.131)	56
O_3	$^1\text{A}_1$	1110 0.138	705 0.087	1042 0.129	32
O_3^+	$(^2\text{A}_1)$	(~1300) (~0.16)	(~700) (~0.09)	(~1600) (~0.20)	†
*Vibrational intervals estimated from Rydberg states of H_2O .					
†Vibrational intervals estimated from NO_2 .					

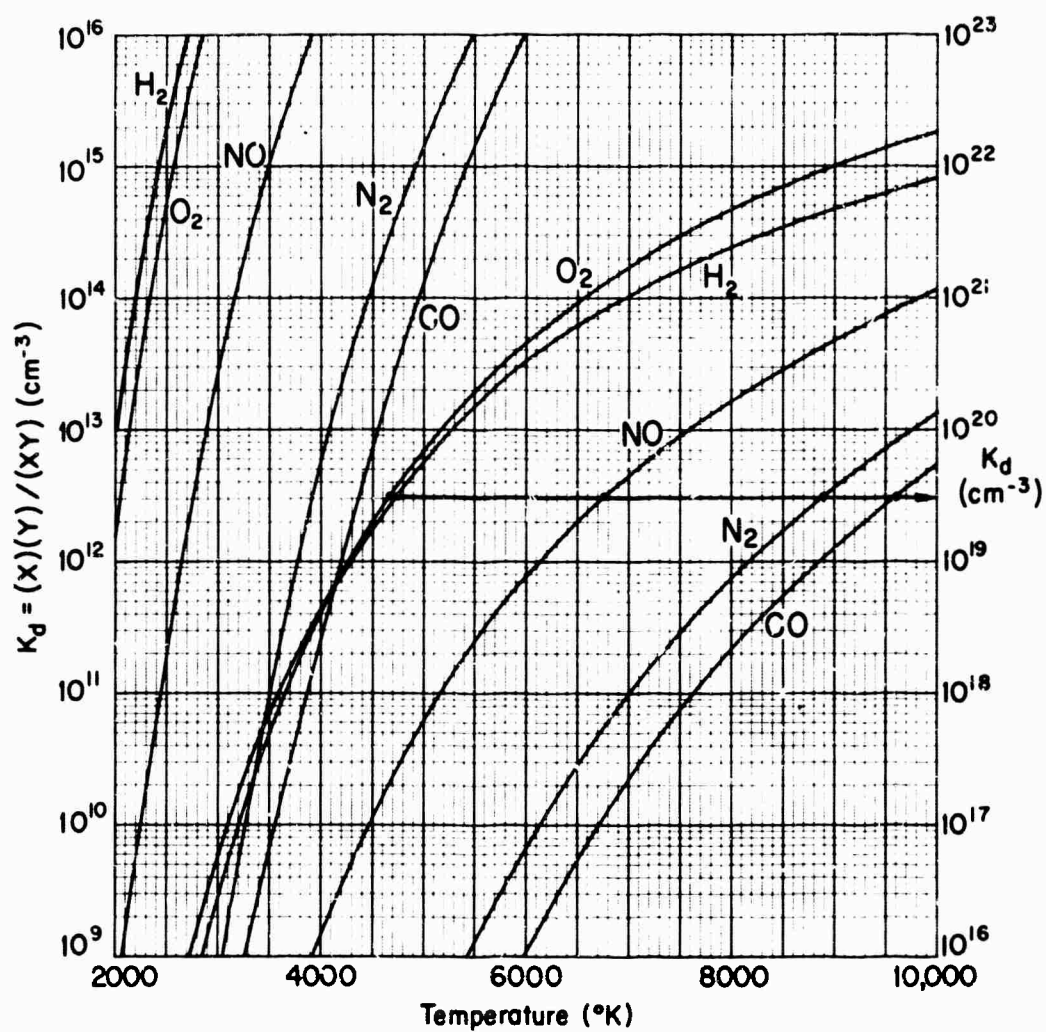


Fig. 1--Equilibrium constants for dissociation

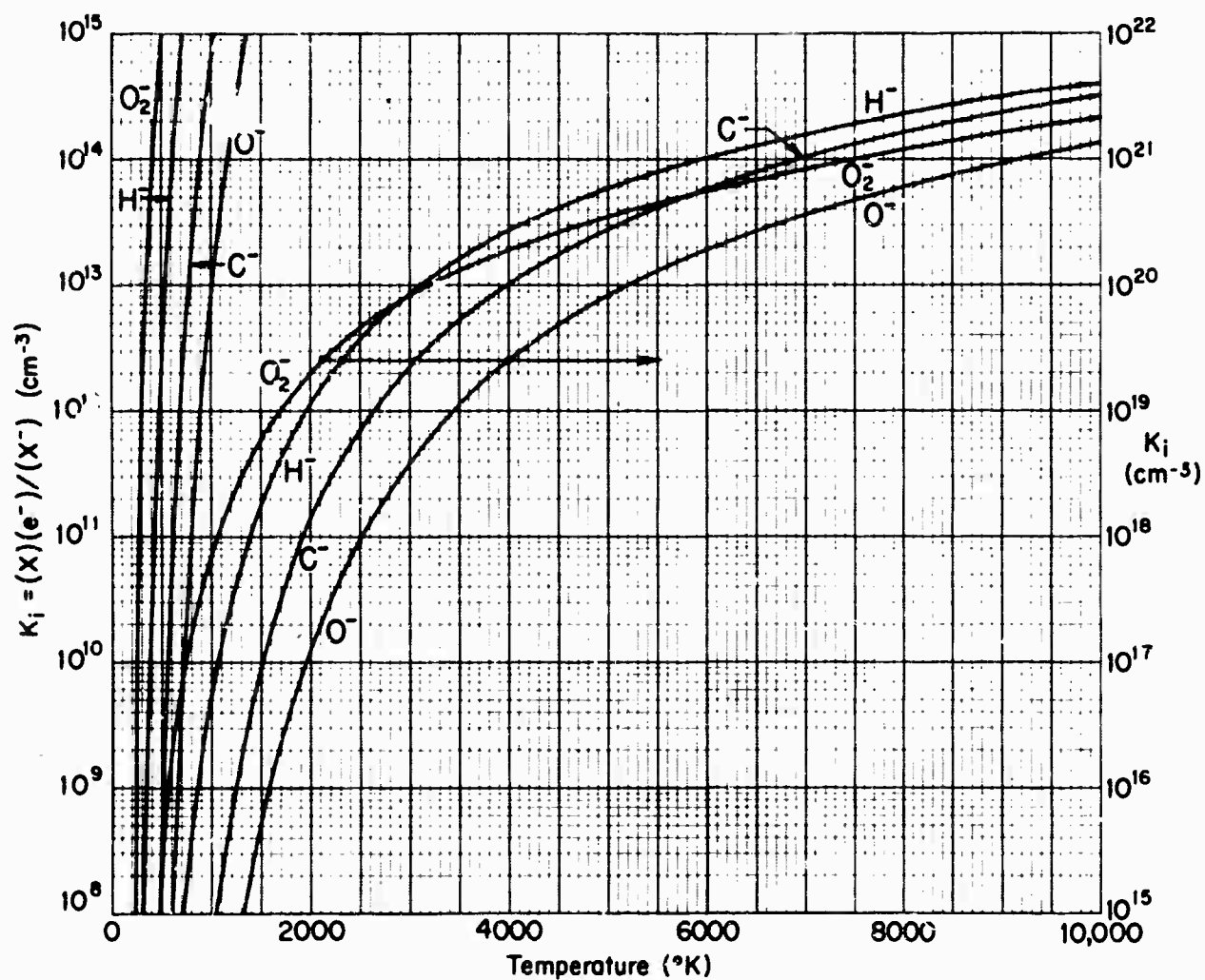


Fig. 2--Equilibrium constants for ionization (detachment) of negative ions

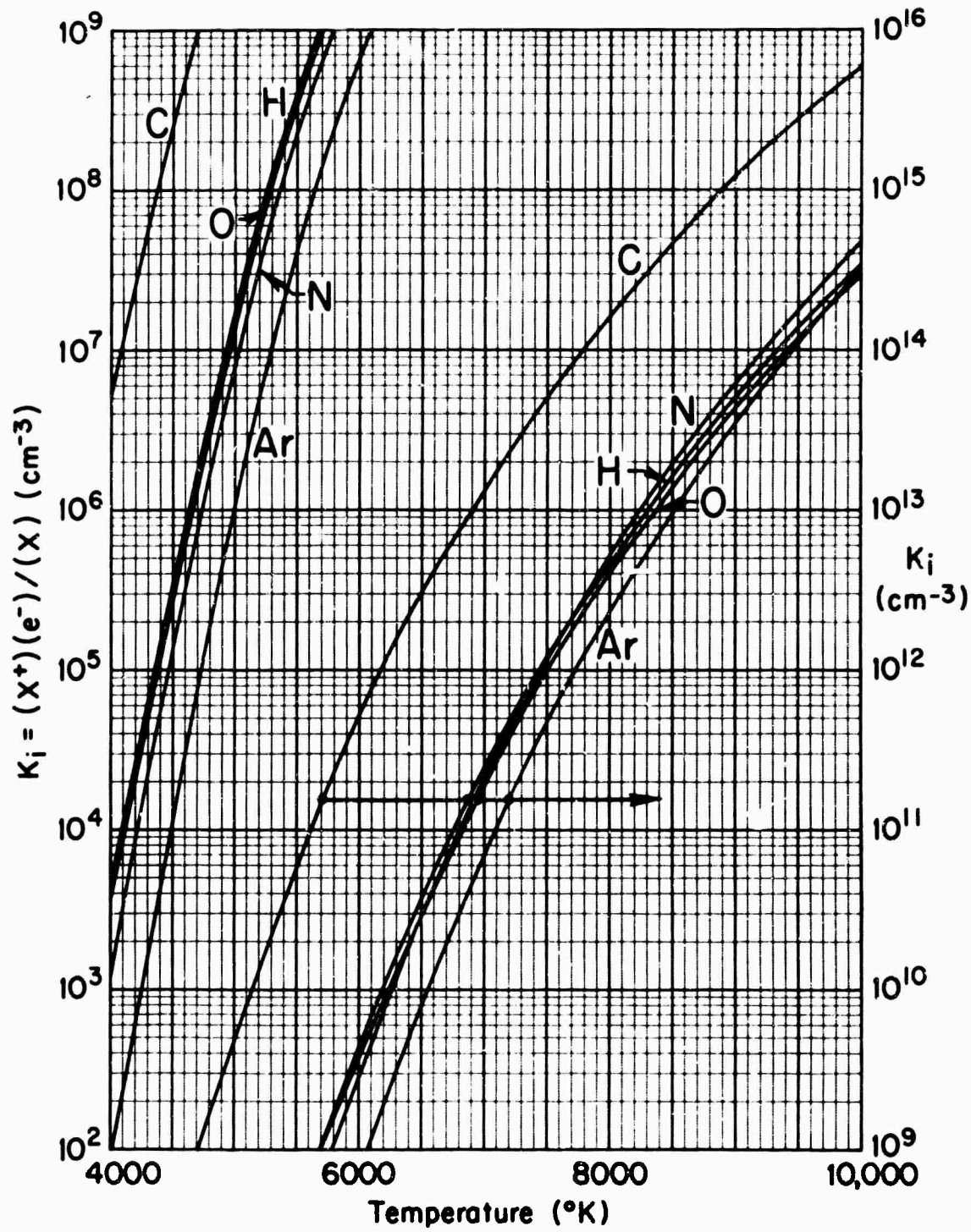


Fig. 3--Equilibrium constants for ionization of atoms

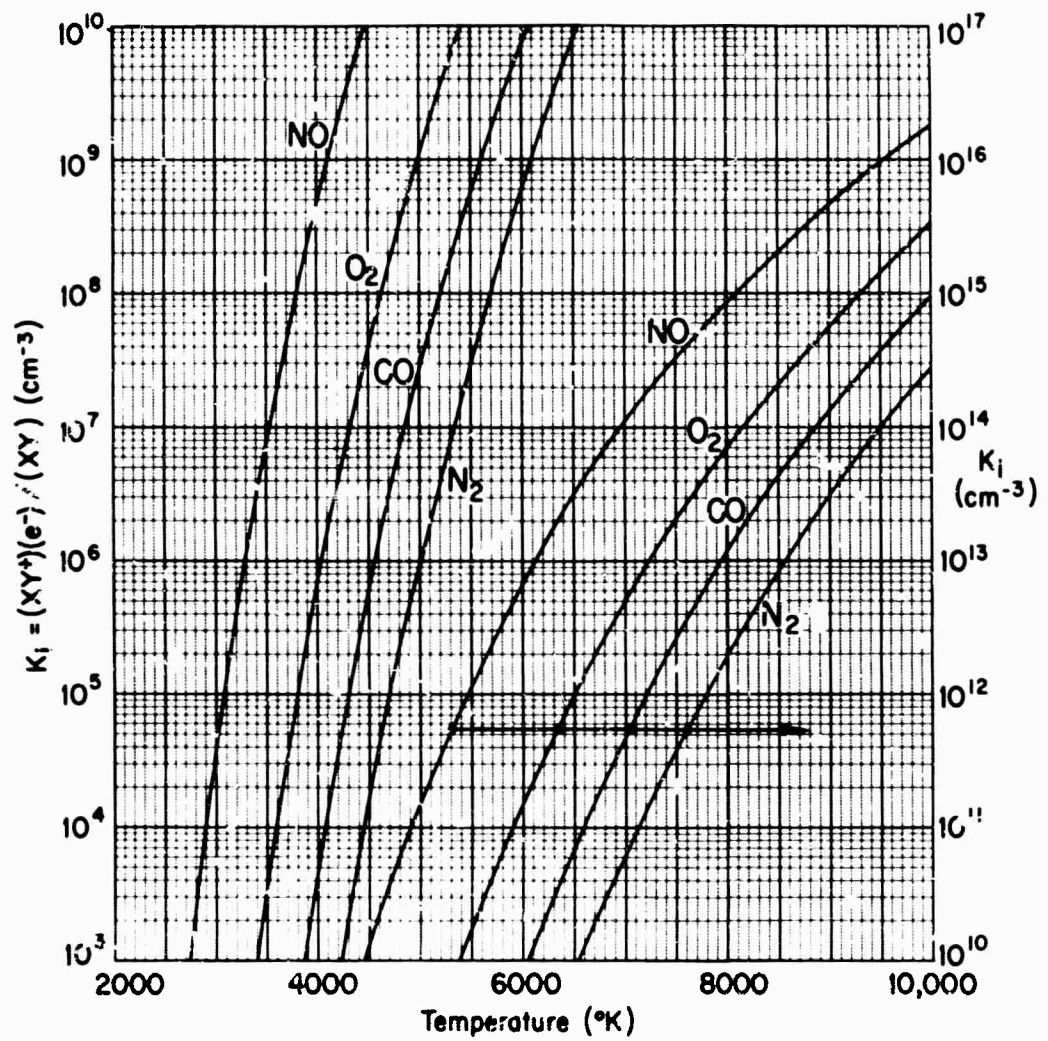


Fig. 4--Equilibrium constants for ionization of diatomic molecules

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DOCUMENT CONTROL DATA

1. ORIGINATING ACTIVITY THE RAND CORPORATION		2a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED	
		2b. GROUP	
3. REPORT TITLE BASIC ENERGY-LEVEL AND EQUILIBRIUM DATA FOR ATMOSPHERIC ATOMS AND MOLECULES			
4. AUTHOR(S) (Last name, first name, initial) Gilmore, Forrest R.			
5. REPORT DATE March 1967		6a. TOTAL No. OF PAGES 52	6b. No. OF REFS. 56
7. CONTRACT OR GRANT No. SD-79		8. ORIGINATOR'S REPORT No. RM-5201-ARPA	
9a. AVAILABILITY/LIMITATION NOTICES DDC-1		9b. SPONSORING AGENCY Advanced Research Projects Agency	
10. ABSTRACT Tables of the formation energies, dissociation energies, ionization energies, electronic energy levels, and vibrational level spacings for most atomic, diatomic, and triatomic molecules involving hydrogen, carbon, nitrogen, oxygen, and argon are presented. Many positively and negatively charged ions are included. Tables of the equilibrium fractional electronic-state populations, and graphs of the equilibrium constants for dissociation, ionization, and detachment for most of the atomic and diatomic species are appended. A brief discussion of the significance of such data precedes the tables and graphs.		11. KEY WORDS Physics Reentry vehicles Atmosphere Radiation Ionization	